Lower Fox River and Green Bay PCB Fate and Transport Model Evaluation

Technical Memorandum 2d

Compilation and Estimation of Historical Discharges of Total Suspended Solids and Polychlorinated Biphenyls from Lower Fox River Point Sources

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Disclaimer

The purpose of this document is to provide estimates of solids and polychlorinated biphenyl (PCB) releases (loads) from facilities discharging to the Lower Fox River. These estimates are intended to support efforts to evaluate the performance of water quality models for the river and Green Bay. This document does not represent an allocation of liability.

Acknowledgments

The primary author of this report was Dale Patterson, Water Quality Modeling Section Chief with the Wisconsin Department of Natural Resources. In the course of compiling necessary information and developing the load estimates, several other organizations provided helpful data. These organizations include the U.S. Fish and Wildlife Service, Green Bay Office and the U.S. Department of Justice. Finally, Appleton Papers, Inc. and Fort James Corp. were very helpful in allowing the Department access to Confidential Business Information that was fundamental to the calculated polychlorinated biphenyl (PCB) mass balance for the Fox Valley.

Revisions to this report were prepared with the assistance of Mark Velleux and James Witthuhn.

This report is dedicated to Dale Patterson.

Note to Readers

The information in this document reflects the most complete understanding of solids and PCB discharges to the Lower Fox River for the period 1954 to 1997. To the greatest extent possible, data from monitoring or discharger records were used to estimate discharges. However, complete records for this period no longer exist and not all existing records were necessarily available to the Department at the time this report was prepared. Should more accurate, verifiable information become available, these discharge estimates may be revised.

During the course of this effort, the Department received access to Confidential Business Information (CBI) provided by dischargers. This CBI contributed to the strength of this report. Although no CBI is presented in this report, CBI is present in many key spreadsheet files used to compute solids and PCB discharges to the Lower Fox River. The confidential status of this information prevents distribution of these files as open records.

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1.0 Executive Summary

This technical memorandum is provided in partial fulfillment of the Model Evaluation Work Plan developed under the Memorandum of Agreement between the State of Wisconsin and the Fox River Group (FRG) of Companies dated January 31, 1997. The companies include P.H. Glatfelter Company, Wisconsin Tissue, Riverside Paper, Appleton Papers, NCR Corporation, U.S. Paper Mills and Fort James Corporation.

Task 2d of the Model Evaluation Workplan calls for development of solids and polychlorinated biphenyl (PCB) loads from all significant point sources that may have contributed solids and PCBs to the Lower Fox River from the mid-1950s to 1997. This report documents the historical data discovered in this process, reports the findings and methods used to calculate loads, and presents the load estimates. These estimates are intended as input for a PCB transport and fate model hindcast simulation that begins at a time prior to significant discharge of PCB to the Lower Fox River.

Nearly all PCB discharges to the Lower Fox River are believed to have resulted from the production and recycle of NCR carbonless copy paper (NCR Paper) made with coating emulsions that contained PCBs. Three pathways of release to the river were identified relevant to PCBs used in the production of NCR Paper. These pathways are: 1) **PRODUCTION** releases of PCBs during the manufacturing process (primarily at the Appleton Papers - Appleton Coated Papers Mill); 2) **BROKE and CONVERTER TRIM** deinking of NCR Paper broke derived from manufacturing and converting processes and sold to deinking mills in the Fox Valley and elsewhere; and 3) **WASTEPAPER/SECONDARY FIBER** recycling which includes post-consumer paper sources that contain some NCR Paper forms or use of secondary fiber sources that contain detectable PCB levels. These three pathways were investigated to determine the total PCB discharge and annual load for each facility that carried out any of the three types of activity during the period of 1954 to 1997.

The estimated cumulative PCB release from all sources was 313,600 kg (based on 3% production loss and 25% partitioning). The release due to NCR Paper production was 122,450 kg and is 39% of the total. The release due to NCR Paper broke and converter trim use was 176,450 kg and is 56% of the total. The release due to waster paper/secondary fiber recycling was 14,700 kg and is 5% of the total discharge.

Two primary factors control the magnitude of calculated PCB discharges. These factors are the rate of PCB loss during coating operation in the production of NCR Paper and the partitioning of PCBs to product during deinking. The production loss rate impacts the mills that produced NCR Paper. Production loss rates vary from 1% to 5%. As a result, discharge estimates due to production vary from 40,000 kg to 208,300 kg. Under any set of assumptions, the amount discharged during production is a significant portion of the total release. The partitioning of PCBs to product fiber impacts the mills that used NCR Paper broke and converter trim. This factor also influences facilities that recycle secondary fiber sources such as wastepaper. Partitioning factors are believed to range from 25% to 75%. A wider range for this parameter may be possible. As a result, the discharge estimates due to broke and converter trim use vary from 176,450 kg to 71,750 kg (higher partitioning factors result in lower overall discharges). Under any set of assumptions, the total amount discharged during broke and converter trim use is a significant portion of the total discharge. Total PCB discharges attributable to wastepaper/secondary fiber are small in comparison to other release pathways and range from 4% to 12% of the overall PCB release. Cumulative PCB releases from all pathways are 399,450 kg if the PCB loss during production of NCR Paper was 5% and 25% of PCBs in broke and trim PCB partition to product. Cumulative PCB releases are 126,450 kg if the PCB loss during production of NCR Paper was 1% and 75% of PCBs in broke and trim partition to product. Waste paper recycle resulted in the least amount of PCB discharge of all three pathways (14,700 kg).

Over 98% of the cumulative PCB load was discharged by the end of 1971. Five facilities account for more than 99% of the PCBs discharged to the river. These include the Appleton Papers-Coating Mill (38%), the P.H. Glatfelter Company and associated Arrowhead Landfill (27%), Fort James-Green Bay West Mill (23%), and Wisconsin Tissue (10%), and Appleton Papers-Locks Mill (2%). Discharges from all other facilities are less than 1% of the total PCB release.

2.0 Introduction

A hindcast from a time prior to the release of PCBs to the Lower Fox River to the present has been identified as a key metric to evaluate the performance of PCB transport and fate models for the Lower Fox River and Green Bay. Nearly all PCB discharges to the Lower Fox River are believed to have resulted from the production and recycle of carbonless copy paper made with coating emulsions that contained PCBs. Historical information indicates early experiments with carbonless copy paper occurred from 1950 to 1953. Commercial production of carbonless copy paper using PCB emulsions began in the Fox Valley in 1954 and continued until the early 1970s when Monsanto, the company that supplied PCBs stopped selling PCBs for uses "open to the environment." Carbonless copy paper produced today uses emulsions that do not contain PCBs. Therefore, a hindcast must cover the period from 1954 to the present so as to represent river conditions prior to the era of significant PCB contamination, during the era of active PCB loading and, finally, during the present era of PCB transport from the sediments.

Successful completion of a hindcast requires input data covering the 1954 to 1988 period. Data covering 1989 to 1995 has been well documented in the Fox River/Green Bay Mass Balance Study and follow up studies done by Wisconsin DNR and others. Data required to run a hindcast includes watershed flows and pollutant loads, effluent flows and pollutant loads, river flows and pollutant loads for all pollutants important to the transport of PCBs. Much of the required data does not exist because it was never measured over this time period or records have long since been discarded. Task 2d focuses on estimating the time history of solids and PCB loads from all known point source dischargers during the 40 year time period. The time history of solids and PCB loads, as well as the settling characteristics of the solids, are critical components of this effort. The importance of the solids characteristics cannot be over emphasized, since PCBs are closely associated with solids and major changes in wastewater treatment at virtually all point sources occurred during this time span, particularly during the 1970s.

It was therefore necessary to reconstruct the best possible estimate of PCB and solids loads during the period based upon data which still exists. While direct data does not exist for PCB concentrations and mass loads, a significant amount of information that can be used to create a reliable estimate of loading was found. Using this data, a method was developed and utilized to estimate the historical loading of PCB and solids from all Lower Fox River point sources. The specific objectives of Task 2d are:

- Identify all major dischargers that operated at any time during the period of PCB discharge.
- Estimate TSS loads from all major discharges to the Lower Fox River.
- Estimate the settling characteristics of TSS loads for each source over time.
- Develop discharge volume estimates for all major dischargers.
- Develop estimates of production for all industrial dischargers during the entire period.
- Compile available PCB effluent data for all identified dischargers.
- Calculate, directly or by extrapolation, PCB loads from each discharger for the period 1954 to 1997.
- Estimate future TSS and PCB loads to the river.

While data are limited, there was sufficient monitoring during this period such that values for key factors could be either calculated or estimated. This allowed a loading hindcast to be reconstructed for the pulp and paper industrial dischargers and most publicly owned treatment plants (POTWs). Other dischargers exist, and some of those discharges might have contained small quantities of PCBs. However, these other facilities are typically small volume dischargers with very low (if not zero) potential for releasing PCBs with the signature composition of PCBs associated with NCR Paper products (Aroclor 1242). Therefore, only information for the paper industry and POTWs are presented in this report.

A few basic definitions are provided to facilitate an understanding of the information presented in this report. The definitions listed below were developed from information presented in the Pulp and Paper Dictionary by John R. Lavigne:

BROKE - Paper trimmings or damaged paper as a result of breaks on the paper machine and in the finishing operations, or anywhere in the process of paper manufacturing. It is usually returned for reprocesing.

CONVERTER TRIM - Paper trimmings or damaged paper as a result of cutting, perforating or printing operations. Similar to broke except that it does not originate from the paper making/coating process.

NO CARBON REQUIRED (NCR) Paper - a special type of copying paper in which the impressed image is transferred from the original sheet to other sheets of paper by means of chemical coatings on the front and rear of the sheets.

OFF-MACHINE COATING - The process of applying coating material to of paper or paperboard in a location that is away from the machine on which it is made. (Note: Appleton Coated Papers produced NCR Paper as an off-machine coating operation. Appleton Locks Mill experimented with on-machine coating to manufacture NCR Paper)

POST-CONSUMER WASTEPAPER - any type of paper product returned for repulping and processing after being used and discarded by consumers.

SECONDARY FIBER - Any type of paper- and paperboard-making fiber obtained from wastepapers and other reclaimable fiber sources.

WASTEPAPER - any type of paper product or fiber source returned to pulping operations for reprocessing.

A brief review of the history of carbonless copy paper is instructive to place this effort in context with events that occurred in the paper industry and the Fox Valley. National Cash Register Company (NCR) (presently AT&T Global Solutions Company) is credited with inventing carbonless copy paper as a result, primarily, of a search for a paper for cash registers not needing an ink ribbon. Barrett K. Green, an NCR researcher demonstrated a paper that would image upon impact, but had little shelf life until a method was found to encapsulate the dye materials. Such a method was demonstrated successfully by Barrett Green in 1950. The method used microcapsules of a waxy material to enclose a colorless dye dissolved in PCBs. This material was made as an emulsion and could be coated onto the back side of a sheet of paper. A second special reactive coating was then put on the front side of a second sheet of paper. Impact on the front sheet would rupture the capsules and allow the dye to react with the coating on the front of the second sheet, thereby leaving an image. Because the capsules were fragile, special paper coating methods and equipment, such as air knife coaters, were required to produce the carbonless copy paper. Appleton Coated Papers was one of a very few coaters that had the necessary equipment and skill to handle the emulsion.

NCR produced the capsule emulsion in Dayton, Ohio and later in Portage, Wisconsin. The emulsion was sold to Mead Paper Company in Ohio and to Appleton Coated Papers in Appleton, Wisconsin. The finished product was bought back by NCR for distribution and sale. Production records provided by NCR indicates that about 67% of the emulsion was sold to Appleton Coated Papers during the period when PCBs were used in the capsules. The 67% estimate is on based NCR Paper production at Appleton Coated Papers and the PCB content of the paper (see Table 2).

At least four types of coating operations were used to make NCR Paper. Coated Back (CB) paper was used as the front sheet in a form and consisted of paper coated with the PCB containing emulsion on the back of the paper. Coated Front (CF) paper was used for the back page of a form and was coated on the front side with the reactive coating that did not contain PCB. Coated Front and Back (CFB) was used for middle pages in a form and was coated with reactive materials on the front and PCB emulsion on the back. Self Contained (SC) paper was coated with both layers on the front side of the paper and was meant to be used as a second sheet in a form and could be used with any type of paper as the cover sheet. Only CB, CFB and SC papers used PCB in the coating material.

Carbonless copy paper production increased nearly exponentially during the 1950s and 1960s (see Table 2). By 1971, Robert Shade of Shade Information Systems, Inc. estimated that 7.5% of all office forms produced up to 1971 were carbonless copy paper. As PCB use increased with production of NCR Paper, PCBs began to occur in many types of paper products due to recycling of NCR Paper BROKE and recycling of paper products made with NCR Paper BROKE. Paper manufacturing frequently involves various levels of internal and external recycling of fiber pre- and/or post-consumer. By the late 1960s, nearly all paper products contained detectable levels of PCBs. Essentially, only virgin pulp and those paper products manufactured solely with virgin pulp (or recycled pre-consumer broke from virgin fiber) were totally free of PCBs. Evidence of PCBs in paper products includes studies conducted by the Institute of Paper Chemistry (now Institute of Paper Science) to determine the rate at which PCBs migrated from paper container materials to the food products contained in them. In an EPA report, "PCBs Involvement in the Pulp and Paper Industry", (EPA 560/6-77-005), Carr, Durfee and McKay document PCB concentrations in paper products between 1968 and 1976 showing that essentially all paper products had detectable levels of PCBs. Included among the data reported by Carr, et al. were measurements by the Fort Howard Paper Company (presently Fort James - Green Bay West) of archived samples of paper stocks recycled at the Green Bay mill. Fort Howard found PCB concentrations that ranged from about one hundred parts per billion to hundreds of thousands of parts per billion and estimated that average paper concentrations exceeded 4000 parts per billion (excluding NCR Paper). Types of paper tested included bleached sulfite, white ledger, colored ledger, kraft clippings and newspapers among others.

For purposes of this report, "NCR Paper" refers to "No Carbon Required" copy paper produced by National Cash Register using PCB emulsions during the period of 1954 to early 1971. According to NCR, PCBs were not used in carbonless copy paper emulsion after April, 1971 as a result of increased concern about PCBs in the environment. During the period when PCBs were used, and shortly thereafter, significant quantities of PCBs were released into the Fox River. Nearly thirty years later, PCBs remain at levels of human health and ecological concern in the water column, sediments, and wildlife of the Lower Fox River and Green Bay.

3.0 Profiles of Lower Fox River Dischargers

The first step in the historical record search was to identify all dischargers for the period 1954 to 1997. Various sources of information were consulted for this purpose. For the period 1973 to the 1997, the Wisconsin Pollutant Discharge Elimination System (WPDES) permits provide an accurate record of all permitted discharges to the Fox River. These permit records include information on the name and location of each discharger and, to a lesser extent, the type of operation and production levels.

For earlier times within the period of concern, historical copies of the Lower Fox River Drainage Basin Reports were utilized. These periodic reports begin in the late 1950s and continue to the present time. The earliest versions list names of dischargers, locations, annual average production, flow and solids loads. Drainage basin reports were generally prepared every five years and typically report data collected one to two years prior to the release of the report.

More systematic data sets were found in the cooperative mill surveys conducted by the Wisconsin Committee on Water Pollution and the Wisconsin Pulp and Paper Industry. These surveys began in the 1920s and continued until 1967 when the Committee was reorganized into the present-day Wisconsin DNR.

Thirty-three (33) dischargers were identified. The name and location of each discharger is presented in Table 1. Information on corporate name changes, closures and consolidations of discharges are listed, to the extent known. Facilities are listed in downstream order by current and former names and location. Only paper mills and POTWs are included as potential sources. Small, miscellaneous sources are not included.

Table 1: Lower Fox River Dischargers.

Number	Discharger Description
1	Kimberly Clark Corporation-Neenah and Badger Globe --- Formerly Neenah Paper (1956), Neenah Dam and Kimberly Clark-Badger Globe. Located side by side above Neenah Dam. Split discharge to river and POTW before combined effluent into one secondary treatment system about 1976. Produced paper and tissue from virgin pulp and purchased small amount of deinked pulp.
2	P.H. Glatfelter Company --- Formerly Bergstrom Paper Company. Located just downstream of Neenah Dam. Primary treatment 1951 and secondary 1978. Produced paper from deinked fiber and purchased virgin pulp.
3	P.H. Glatfelter-Arrowhead Landfill: disposal site for P.H. Glatfelter Company solid waste from 1951 to 1975. Waste placed in landfill was subject to wave action and runoff until the confining berm was sealed when the landfill was closed in 1975. Runoff to Little Lake Butte des Morts observable in aerial photos.
4	American Tissue Mills --- Formerly Kimberly Clark-Lakeview. Southern end of Little Lake Butte des Morts, west side. Primary treatment in 1967. Produced paper and tissue from virgin pulp and small amount of purchased deinked pulp.
5	Mead Corporation, Gilbert Paper Division. Rag pulp mill made premium and security paper. Sent effluent to NM POTW about 1975. Produced legal paper and currency from high quality virgin pulp and rags.
6	U.S. Paper Mills Corporation, Menasha Division --- Formerly Menasha Company, John Strange Paper Corporation. Sent all effluent to NM POTW about 1975. Located on Menasha Channel. Paperboard and core mill using secondary fiber.
7	American Can Canal Plant, Menasha --- Formerly Marathon Corp. On Menasha Channel. Eleven (11) tons per day, fiber recovery and water reuse. 1957: savealls to Menasha Channel
8	George Whiting Paper Corporation. Book mill. Sent effluent to NM POTW about 1975.

Table 1: Lower Fox River Dischargers (continued).

Number	Discharger Description
9	Neenah-Menasha POTW. Serves Neenah and Menasha. Replaces Menasha East POTW about 1983. Mills sending partial waste stream in 1957 include KC Neenah/Badger Globe, Mead, U.S. Paper-Menasha, Wisconsin Tissue and George Whiting. Discharges at the end of Menasha Channel entry into Little Lake Butte des Morts. Likely significant PCB load from Wisconsin Tissue with minor load from some others. Bypassing important.
10	Wisconsin Tissue Mills. Deinking/recycle mill located in Menasha. Discharges through NM POTW from 1936 until 1975, however, cooperative mill surveys presents data on discharge through 1960. Substantial quantity was likely bypassed directly to the river in collection system or at NM plant. Pretreatment of primary and secondary. Direct discharge to river in 1976. Produced tissue products from deinked fiber and purchased virgin pulp.
11	Menasha East POTW. Phased into NM POTW about 1983.
12	Menasha West POTW. Located on west side of Little Lake Butte des Morts. Aroclor 1254 detected in effluent. Closed in 1983 when Grand Chute/Menasha West came on line.
13	Grand Chute/Menasha West POTW. Located on west side of Little Lake Butte des Morts and discharges near north end lake.
14	Riverside Paper Corporation, Kerwin Paper Division --- Formerly Amricon Corporation-Kerwin Paper, formerly Riverside Paper Corporation. Located on islands between upper and middle Appleton Dam. Split discharge between river and Appleton POTW to meet permit limits. Fiber recovery is only treatment. Produced bond paper from purchased virgin pulp and secondary fiber deinking after 1967.
15	Consolidated Paper, Appleton --- Formerly Consolidated Water, Power and Paper Corporation. Located just down from lower Appleton dam on east bank. Closed in 1983, dismantled in 1987. One detect of 1254. Produced virgin sulfite pulp.
16	Appleton POTW. One mile north of College Avenue bridge. Frequent bypassing during 1950s, 1960s and 1970s prior to major expansion. Bypassed before primaries all flow above 19 mgd before major expansion. Primary plant in 1957 and secondary in 1964 with major upgrade in 1979. Between 1964 and early 1979, diverted effluent to river after primary treatment (and chlorination) when applied BOD_5 load to secondary system exceeded organics loading capacity. Received waste from Riverside, NCR Appleton Papers, Appleton Coated Papers, Fox River Paper, KC Atlas and others. Significant load likely from Appleton Coated and smaller load from Riverside.
17	Fox River Paper Company --- Formerly Fox Valley Corporation. NI fine and post-consumer recycled paper. Discharges to Appleton POTW. No information on flow, TSS or production 1954-1997. No estimate can be made unless some of this data is available. Potential to contribute PCB to Appleton POTW.
18	Consolidated Paper, InterLake Paper Inc. --- Formerly Repap, Wisconsin Inc., formerly Midtec Paper Company, formerly Kimberly Clark, Kimberly Mill. Located right on the Kimberly Dam. Was a sulfite pulp mill, now ground wood and NI fine coated paper manufacture. Prior to piping sewers in 1973, discharged below the dam. Secondary treatment system and discharge pipe now located upstream of mill. No PCB detects in effluent data. May have used secondary fiber sources.
19	Appleton Papers, Incorporated, Coating Mill --- Formerly NCR Appleton Papers, formerly Appleton Coated Papers Company. Discharge went to Appleton POTW sewer with bypass potential at Green Bay Road crossing and at the POTW. Primary coating operation that manufactured NCR Paper.
20	Appleton Papers, Incorporated, Locks Mill --- Formerly NCR Appleton Papers, formerly Appleton Papers, Locks Mill, formerly Combined Locks Paper Corporation. Located below Little Chute Dam on east side of river. Primary in 1972 and secondary in 1975. Deinking and book mill, now groundwood chemi-mech pulp and NI fine and carbonless paper. Used PCB containing emulsion to produce NCR Paper: July (December?) 1969 through April 1971.

Table 1: Lower Fox River Dischargers (continued).

Number	Discharger Description
21	Kimberly, Little Chute, and Kaukauna POTWs. Small POTWs serving respective communities using trickling filters or activated sludge. Kimberly activated sludge in 1957. Little Chute primary in 1957. Kaukauna primary in 1957 and receives some paper mill waste in 1950s. All were phased out and combined into Heart of the Valley POTW in the late 1970s. Some low-level detects of Aroclor 1254.
22	Heart of the Valley POTW. Put on line in late 1970s to replace POTWs listed above. Discharges below lower Kaukauna dam just below Lock Number 5.
23	International Paper Corporation, Thilmany Division --- Formerly Hammermill, Thilmany Division, formerly Thilmany Pulp and Paper Corporation. Located just down from lower Kaukauna dam on west side. Kraft pulp and NI fine and NI lightweight paper mill. Uses lagoons and aerated lagoons and UNOX treatment.
24	Wrightstown POTW. Very small POTW discharges above Rapide Croche Dam. Aroclor 1254 detected once.
25	Charmin, Little Rapids Mill. Small groundwood mill located at Little Rapids Dam. Closed mid-1960s.
26	International Paper Corporation, Nicolet Paper Division --- Formerly Hammermill, Nicolet Division, formerly Philip Morris, Nicolet Division, formerly Millprint, Incorporated. Built over the river and DePere Dam on the west side. Glassine mill and specialty paper.
27	U.S. Paper Mills Corporation, DePere Division --- Formerly U.S. Paper Mill corporation. Primary treatment discharges to river below DePere Dam on west side. Discharges to DePere POTW 1973 on. Paperboard, core stock and cores using secondary fiber from OCC, DLK and boxboard.
28	DePere POTW. Located about 1/2 mile below DePere Dam at most narrow point. Frequent collection system overflows in 1960s and early 1970s before major upgrade in mid-1970s. Primary in 1957 with frequent overflows due to combined sewers. Treated U.S. Paper, DePere waste stream from 1973 to the present. Several detects of Aroclor 1254.
29	Fort James Corporation, Green Bay West Mill --- Formerly Fort Howard Corporation, formerly Fort Howard Paper Company. Located 3.5 miles upstream of river mouth on west side. Began treating with lagoons in early 1950s. Improved treatment lagoons and added secondary in early 1970s. Deinking/recycle tissue mill.
30	Procter & Gamble Paper Products Company --- Formerly Charmin Paper, formerly Hoberg Paper Mills 1948. Located between East River and Fox River mouth on east side. Pulp waste sent to GBMSD in mid-1970s. Tissue produced from virgin sulfite and groundwood pulp and more recently purchased virgin pulp with small amounts of secondary fiber.
31	Green Bay Packaging Incorporated --- Formerly Green Bay Paper and Pulp Corporation located about 1.5 miles from the river mouth on the east side. Used reverse osmosis to treat waste in mid-1970s, now advanced tertiary. Corrigated products using semi chemical pulp and secondary fiber including OCC, DLK, old newspapers and other secondary fiber sources.
32	Fort James Corporation, Green Bay East Mill --- Formerly James River Corporation, formerly American Can Corporation, formerly Marathon Corporation, formerly Northern Paper Mills. Paper waste treated in a lagoon and discharged to first slough on east side of river above mouth. Pulp waste to GBMSD till purchased pulp. Sulfite pulp and coated paper, later tissue (and deinking?), now NI tissue.
33	Green Bay Metro Sewerage District. Located 1 mile upstream before major upgrade moved plant directly to river mouth in 1977. Primary in 1957 with combined sewers and frequent bypassing. Treated pulp waste for Procter & Gamble and James River in late 1970s and early 1980s.

4.0 Total Suspended Solids and Effluent Flow Volume Compilation

Point source total suspended solids (TSS) loads and flow were compiled for each point source identified in Table 1 for the period 1954 to 1997. Data was compiled and reported as monthly average discharges in pounds of TSS per day and millions of gallons of water discharged per day (MGD). These units were used for ease of data manipulation since virtually all records present data in these units.

Three primary data sources yielded most of the available data in the record and covered nearly all years for the mill dischargers. Data gaps in records for municipal dischargers resulting in more reliance on records obtained from the municipality or other documented sources. If reported values were available for any time period, those values were used directly. Interpolations/extrapolations were only applied after all data sources were exhausted and no data for a particular period was available. If more than one source was available for similar time periods and the values conflicted, then data from the three most abundant sources tended to be used over miscellaneous sources or a judgment was made as to the most reliable data to use.

Cooperative Mill Surveys: Cooperative surveys yielded discharge estimates for all paper mills for the period 1954 to 1967. These survey results were found in DNR files, but more complete records were located in Wisconsin Historical Society records where annual summaries of the cooperative surveys were found. In addition, bound books in DNR files yielded a complete set of annual summary sheets of the cooperative surveys going back to 1926. The data in these summaries was given in terms of a numeric discharger listing, with no names of dischargers included. It was therefore necessary to find keys to the summaries in order to relate the data to the correct discharger. Some keys were found in DNR files; at least one key was found in the bound books but most keys were found in the Historical Society files. Together, the keys discovered allowed the summary tables to be used for all years between 1954 and 1967.

Relevant data presented in the cooperative mill surveys included: gallons of wastewater per ton of product; pounds of fixed, volatile and total solids per ton of product; pounds of BOD_5 per ton of product and, finally, pounds of BOD_5 discharged per day. The last two measurements were important because they allowed calculation of production in tons. With production calculated, flow volume was then calculated from the gallons of wastewater per ton of product times total production tons and TSS was calculated as the sum of fixed and volatile solids per ton of product times total production in tons. To verify that this was a correct interpretation of the cooperative survey summaries, these results were cross checked with tables of mill discharge volume and TSS discharge presented in various summary documents that could be found in the existing files, such as basin reports. Cross checks produced identical results for flow, in MGD, and TSS, in pounds per day, in these comparisons when exact years of data summaries were known. This verified that the cooperative survey data was being used correctly to calculate mill discharges.

The cooperative mill surveys were usually based on one survey period that may have spanned two to five days at any facility. The reported results were presented as representative of annual mill operations in the cooperative survey summaries. Therefore, cooperative mill data were used for all 12 months of the reported year. In later years, when effluent permitting under the Clean Water Act began, better monitoring of total mill discharges appeared to indicate that some of the cooperative mill surveys did not include all outfalls at a few facilities. This means that load estimates based on cooperative mill survey data may tend to underestimate actual discharges. The magnitude of potential unmonitored discharges cannot be determined. Therefore, cooperative mill survey data were used without modification.

Self Monitoring Reports (SEMOREs): The next most significant source of discharge data consists of summaries of the Self Monitoring Reports (SEMORE) submitted by each discharger in accordance with Wisconsin Pollutant Discharge Elimination System (WPDES) permits issued under the Clean Water Act. SEMORE reports consisted of monthly reports that listed daily discharge volume and mass or concentration of specified pollutants. These documents were used during the April 1973 to December 1981 period to provide monthly summaries of discharge for BOD_5 and TSS given to the Natural Resources Board for all pulp and paper mills in the state. Some of the years had major municipal dischargers summarized in the same way.

SEMORE reports were submitted by each discharger monthly and were filed with WPDES permit documents. Files for these early years of the permit program had largely been discarded by 1997. The summary reports to the WDNR Natural Resources Board (NRB) were preserved in DNR files and are, available as a record of paper mill discharges of TSS and BOD during this period. While copies of the individual monthly reports may still be retained by individual mills, recovery of mill retained documents was not pursued as part of this task. To date, no facility has indicated that they have retained these records. The summary reports did not include flow volume. Therefore data for flow volume was compiled from a variety of sources including dissolved oxygen modeling data sets used to create wasteload allocations, some preserved copies of SEMORE reports and Water Quality Management Plan reports that summarized discharges along the Fox river. Additional information was provided by the U.S. Fish and Wildlife Service (USFWS) from data collected as part of Natural Resource Damage Assessment (NRDA) efforts.

Discharge Monitoring Reports (DMRs): The most recent 15 years of discharge data from 1982 to 1997 was available in electronic form from monthly summaries stored in DNR computer files using Discharge Monitoring Reports (DMR) data. The electronic data base was essentially complete for all dischargers, industrial and municipal, along the lower Fox river that held a WPDES permit during this period.

Data from all sources was assembled into spreadsheets listing flow, and TSS discharge by month for the entire period starting with January 1954 and going to June 1997. The spreadsheets were broken into 3 separate sheets for handling ease due to the size of the file. Virtually all dischargers had periods were no data were available for either flow or TSS discharge. These data gaps were filled by interpolation or extrapolation based on data surrounding the gap period and other information relevant to the discharger that may have caused flows or loads to change during the period of the gap. Since the solids balance is critical for any hindcast model simulation, all dischargers had TSS loads completed for every month (including the gaps were interpolation was necessary). However, only those dischargers identified as potential PCB sources had discharge flow gaps completed by interpolation.

Municipal Bypassing Summary: Many drainage basin reports and pollution hearings refer to frequent bypassing at municipal wastewater treatment systems, especially during the 1950s and 1960s. Bypassing can occur in three ways. First, insufficient capacity at the treatment plant could result in bypassing a portion of the incoming flow from part or all of the treatment plant (control diversions). Treatment capacity could be exceeded when flows or organic loadings were greater than a plant's maximum ability to treat wastewater. Second, combined sewers were designed to overflow during periods of rain or snow melt. Third, overflows in the collection system (for example due to insufficient lift station capacity or excessive infiltration/inflow) could result in discharges to the river prior to the flow reaching the treatment plant even during dry weather. Estimates of bypass volume were made for the Neenah-Menasha, Appleton, DePere and Green Bay POTWs. These estimates were based on qualitative statements found in pollution investigation documents from the 1950s, 1960s and 1970s. The information in pollution investigation documents was generally applicable to the first two types of bypassing. Bypass estimates were augmented wherever possible by quantitative data specific to each POTW.

Several of the sewer collection systems contained significant areas of combined sewer systems that were subject to wet weather bypasses. CSOs were assumed to bypass up to 5% of the flow volume reported for the facility unless specific data were available. For example, several documents indicated that the Neenah-Menasha POTW had larger bypasses due to inadequate sludge handling. For this facility, as much as 25% of the flow may have been bypassed during some periods. In-plant bypasses (control diversions) were also calculated for the Appleton POTW for periods when the monthly average flow approached the plant hydraulic capacity or when applied BOD_5 loadings exceeded the secondary treatment system loading capacity. A characteristic concentration was then applied to the estimated flow bypass to calculate a bypassed TSS load. These values are shown on the spreadsheets in a separate column. The bypassed flows contributed significant TSS loads due to the high raw waste TSS concentrations. Bypassing also affected PCB loads if PCBs were contributed to the treatment plant from paper mill sources.

The following is a description of known by bypassing from municipal POTW for the period 1954 to 1997:

Neenah-Menasha POTW

Total bypassed flow is based on the reported days per month and volume bypassed at the plant that was reported through 1964 and sporadically in the 1980s. This data was obtained through the USFWS. A TSS concentration of 250 mg/l was used to compute bypass loads. The bypass TSS value was based on the 1972 Enforcement Conference that indicated a BOD_5 concentration of 262 mg/l. The bypass estimates do not include combined sewer or collection system bypassing. Neither the 1957 Hearing nor the 1972 Conference refer to combined sewers or collection system bypassing. Although the 1972 Conference indicated that substantial bypassing occurred through 1971, bypasses for 1965 through 1971 were estimated since no records for this period exist according to plant personnel. The bypass estimates for this period assumed the same percent of influent flow was bypassed as reported in 1964 (approximately 2.3%) with higher percents assumed when influent flows exceeded 12 MGD.

Appleton POTW

Bypassing at the Appleton POTW is summarized in a 1974 report by Consoer, Townsend & Associates. This report indicated that prior to 1973, twenty-six collection point bypasses existed. After 1973 the number of collection bypasses was reduced to nine. The report indicated that the POTW had average infiltration and severe inflow problems. Domestic water use was about 3.1 MGD, industrial contribution about 5.9 MGD, wet weather infiltration about 4.0 MGD and wet weather inflow 35.6 MGD for a total daily maximum flow of 48.6 MGD. The plant was hydraulicly overloaded at flows above 19 MGD. The Number 1 bypass was located at the head end of the treatment plant between the grit/screening chamber and the primary clarifiers. Bypassing occurred by overflow when inflow exceeded 19 MGD. The report indicated that this bypass operated 82 days in 1972 and 98 days in the first 9 months of 1973. Other significant bypass points include the Number 8 bypass which was located at the inverted siphon river crossing at Green Bay Road. Flow studies indicated significant wet weather bypassing at this location. Bypass points Number 1 and Number 8 are significant since Appleton Papers-Coating Mill wastes would have bypassed treatment from these two points. The bypass estimate is based on 5% of average inflow due to the above referenced collection system problems. Bypassing was phased out starting in 1974 and ended in late 1979 when a major upgrade went on line. The bypass TSS concentration was estimated to be 310 mg/l based on 1972 Enforcement Conference indicating a BOD_5 raw concentration of 320 mg/l. The bypass amount was a direct discharge to the river and reduced the mass of PCBs entering the plant for treatment.

In addition to collection system bypasses prior treatment as a result of hydraulic conditions, in-plant bypasses (control diversions) also occurred at the Appleton POTW due to organic overloading. The 1964 Appleton POTW upgrade expanded the primary treatment capacity of the plant and added a secondary treatment system. The overall plant was designed to treat an average annual BOD_5 load of 14,460 lb/day with a maximum monthly load of 22,800 lb/day. However, the secondary treatment system was designed to handle a maximum load of only 15,700 lb/day BOD_5. Due to higher than projected BOD_5 loadings from high strength sources such as Stokely Foods, Foremost Dairy, and other industries, in-plant bypasses were necessary at the Appleton POTW from 1964 through 1979 when applied loadings to the secondary treatment system exceeded approximately 15,700 lb/day after primary treatment. These control diversions were used to maximize overall treatment plant removal efficiencies.

DePere POTW

The 1957 Hearings indicated only 32% of combined sewers had been separated. It is not known when the remaining combined sewers were separated. A 1972 Enforcement Hearing indicated the DePere POTW received 3.5 to 7.3 MGD of inflow but only treated 2 to 3 MGD, implying the rest was bypassed. Bypass calculations assumed that before 1972 5% of flow was bypassed with a gradual phase out of bypassing by 1978. In addition, flows above 2.0 MGD were assumed bypassed at the plant up through 1970 and above 2.5 MGD after 1970. The bypass TSS concentration was estimated to be 300 mg/l based on a BOD_5 concentration of 340 mg/l in 1972.

Green Bay MSD

The case summary of Arthur Kafton et. al. vs. Green Bay, 1969, indicated that bypassing occurred 7.4% of the time with a total volume of 10% of inflow to the collection system during 1964-1968 and a raw TSS concentration of 352 mg/l. This was extrapolated to a bypass of 5% for 1954-1956, 7.5% in 1957, 10% for

1958-1969 and decreased to 0% by 1976. The bypass TSS concentration was assumed to be 352 mg/l for all periods.

Appendix A, Table A-1 lists the data sources used to compile the TSS and flow records for all 32 point sources identified. A complete listing of the flow and TSS data is available on 3 1/2" diskettes in Microsoft Excel version 5.0 format. This information is also available via the Wisconsin DNR anonymous FTP (file transfer protocol) site: *geotiu.dnr.state.wi.us* (web URL *ftp:\\geotiu.dnr.state.wi.us*) in the *FOXRIVER.DIR* directory. Graphs of flow and TSS discharge for each discharger are shown in Appendix A.

Figures 1-3 show the total TSS load over the period for paper mills, municipal discharges and the total combined TSS load. The summary graphs show gradually increasing loads of TSS which paralleled paper mill production increases and population growth until 1970 when TSS loads began to decline. Dramatic declines are shown between 1971 and 1975 followed by significant, but more gradual reductions up to 1997. Mill production rates have continued to increase throughout the entire 43 year period, with the exception of declines in the production of virgin pulp.

Settling Characteristics of TSS Load Over Time: The settling characteristics of the TSS load from each discharger changed significantly over this 43 year time span. Inspection of TSS load graphs show significant load reductions in the early 1970s in response to permit limits required by the Clean Water-Act and pollution abatement orders issued by the Wisconsin DNR. (Some treatment was installed during the 1950s and 1960s mostly consisting of savealls for paper mill waste streams). The Clean Water Act requirements resulted in the construction of end-of-pipe treatment at nearly all industrial plants and improved secondary treatment at all municipal plants. To estimate the change in solids characteristics, it was assumed that each discharge contained solids that settled in 2 general rates: fast and slow. Since most treatment systems relied on gravity settling, faster settling particles would be removed most readily and low settling rate particles removed less efficiently or not at all. In addition, secondary treatment plants replace raw solids with bacterial flocs during the aeration step. The floc material that escapes the secondary clarifiers make up the bulk of the solids load from such treatment systems.

To simplify the analysis of the characteristics of the TSS solids, the TSS load was divided into two types. Type 1 consisted of solids that were partially captured in primary treatment systems (clarifiers or lagoons) and Type 2 consisted of solids that were not captured in primary treatment. It was assumed that both types of solids consist of broad distributions of actual particles and settling rates and that some overlap exists between the particle distributions in both types. However, the mean settling rate of Type 1 and Type 2 solids would be significantly different with Type 1 solids settling much faster. In the following discussion these types will be referred to as high and low rate settling solids respectively. In order to estimate divisions of high and low rate solids at each discharger over the 43 year period, the procedure documented below was used:

TSS Characteristics Calculation Method

1. By inspection of the TSS data and graph, determine average TSS load before primary treatment system addition and TSS load after primary treatment.

2. Use information on type of treatment used and estimate percent of high rate solids removed.

3. Assume no low rate solids are removed by primary treatment.

4. Write equations for initial and final TSS load as:

$$\text{TSS(initial)} = \text{HR(initial)} + \text{LR(initial)}$$
$$\text{TSS(final)} = \text{HR(final)} + \text{LR(final)}$$

where: HR = High Rate settling TSS load
LR = Low Rate settling TSS load

5. By assuming no low rate solids settling [LR(initial) = LR(final)] and estimating the high rate percent removal, we can solve for the 4 unknowns. An example will illustrate.

Example calculation for solids characteristics using Calculation Method:
Using P.H. Glatfelter TSS data during the 1966 to 1977 period, we see by inspection of the loading graph that TSS loads dropped from around 43,000 pounds per day to 15,000 pounds per day following construction of an improved clarifier. Assume 90% removal of fast settling solids and 0% removal of slow settling solids:

HR initial = 31,111	and LR initial = 11,889	for a total of 43,000 pounds
HR final = 3,111	and LR final = 11,889	for a total of 15,000 pounds

This results in 28% of the TSS load being low rate settling solids prior to clarifier treatment and 79% of the TSS load being low rate settling solids after clarifier treatment. Finally, aeration and final clarifier treatment was added in 1977 with another significant drop in TSS load. Primary clarifiers, aeration and final clarifiers were assumed to remove all HR solids, yielding an effluent with 100% low rate settling solids.

The settling characteristics of each point source were calculated in this manner for the entire 43 year time span and are included in Table A-1. The results are indicated in the spreadsheets supplied on diskette (or the Department FTP site) below the title of each discharger and are given as the percent of the total TSS load that consists of low rate settling solids for each time period indicated.

Division of TSS loads into two general settling classes has potential implications for PCB transport and fate model hindcast efforts. Primarily, it means that hindcast simulations may require two separate solids classes (state variables) to simulate point source TSS loads over the hindcast period. These two solids classes would be in addition to any abiotic solids class used to simulate sediments. The total organic carbon (TOC) content of each solids class will have to be determined as well. However, both solids classes would be expected to contain highly organic material. Therefore, an initial estimate might assume an equal TOC content for both solids classes needed to represent point source discharges.

5.0 Pulp and Paper Mill Production Data

A key factor in the determination of hindcast PCB loads is the production rate at facilities that may have discharged PCBs. NCR Paper production information was obtained from Appleton Paper. In addition to NCR Paper production, PCBs entered mill discharges primarily through the use of "broke" material coming directly from the manufacturing of NCR Paper or the recycle of post-consumer paper that contained some NCR Paper. In either case, it is necessary to estimate the quantity of material processed by each mill for fiber. In particular, the amount of NCR paper broke used at each mill and the wastepaper deinked per year are the most important production factors.

Production rates are used in conjunction with flow, solids discharge, and known concentrations of PCBs to calculate PCB loads due to wastepaper recycling. One method to calculate historical PCB discharges is to determine the ratio of TSS discharged per ton of production for each year from 1954 to 1997. Data from years when PCB concentrations were measured in effluents was then used to calculate discharges. This process requires an estimate of annual production for each facility over the 43 year time span.

Sources of production data include the Lockwood Directory of pulp and paper mills (later the Lockwood and Post Directory). This publication provided estimates of mill production capacities in various categories. These production estimates relied on each mill to self-report and update production capacities. Accurate self-reporting may not have always occurred since many of the mills reported constant production over years when production likely increased as reported through other means. Also, the Lockwood Directory information may not have been always been up to date and may have lagged behind actual production by a year or two due to reporting delays.

A second means of determining production used the Cooperative Mill Surveys performed up to 1967. As indicated Section 4.0, data contained in these surveys allowed calculation of mill production during the week of the survey. These estimates were assumed to be representative of annual conditions and are used that way in this report. However, it should be noted that the small time period during which the cooperative mill survey data were collected may not always have been representative of annual averaged daily conditions at a facility.

Finally, the WPDES permit program, which began in 1973, contains permit applications that require submittal of mill production capacities. Every five years, each discharger is required to submit production information with their discharge permit application. All information existing in Department permit files was consulted.

Finally, several mills reported production data in response to USFWS interrogatories. Much of this information was submitted as Confidential Business Information (CBI). Attempts were made to obtain authorization to access this material to improve production estimates. Where authorization to access CBI was obtained, this information was used in the calculations of solids and PCB loads from a facility. Although CBI data was consulted in this process, no CBI is presented or otherwise revealed in this report.

Production information was combined into a spreadsheet listing production on an annual basis for each category that was itemized and the source of the data. All information was used to develop a best production estimate for each mill that had a PCB loading hindcast developed. Production estimates for the relevant period were developed for all sources evaluated as potential PCB dischargers. Appendix B presents the complete production database compiled in this study except for data obtained through USFWS restricted as CBI.

Production data represents one of the most uncertain aspects of the methodology to hindcast PCB discharges. It is possible that further information provided by the mills on historical production figures could improve TSS and PCB load calculations and reduce uncertainty.

6.0 PCB Effluent Data and Other Media PCB Data

A significant amount of PCB effluent concentration data was collected by the Department during the first few years after PCBs became an environmental concern in 1971. Sampling was targeted to major flow volume dischargers across the State in an attempt to discover sources of the PCBs showing up in biota in the Great Lakes and tributaries such as the Lower Fox and Milwaukee Rivers. Analytical methods were not as refined as present-day methods, with detection limits of 0.2 ug/l (200 ng/l) being obtained for total PCBs for most samples of sewerage and paper mill waste. This report does not discuss laboratory methods used for the analysis of PCB in various media including effluents, water, sediment and biota. Results are reported with limits of detection (LODs) indicated, if given. The earliest sampling in 1972 and 1973 targeted large municipal wastewater treatment plants rather than paper mills. Trace concentrations (above typical LODs of 0.2 ug/l) of Aroclor 1248 and 1254 were reported in many samples. By 1974 and 1975, large concentrations of Aroclor 1242 (hundreds of ug/l) had been detected at three recycling mills in the Fox Valley as well as smaller concentrations of 1242 at other paper mills and sewage plants along the Lower Fox River. Between 1974 and 1978, many more PCB samples were collected from all of these sources with most frequent sampling occurring at the recycling/deinking mills where the highest concentrations were found.

PCB data from this era is documented in Appendix C. Samples are listed by State Laboratory of Hygiene note book, discharger name, date reported, type of sample (raw waste, final waste, sludge, etc.), reported concentration and Aroclor, if given. Virtually all major dischargers, paper mills and municipal treatment plants were sampled at least once. P.H. Glatfelter (Bergstrom Paper), Fort James-West (Fort Howard) and Wisconsin Tissue have by far the most samples available. P.H. Glatfelter and Fort James-West had monthly or biweekly sampling reported for most of 1975 through 1978. Wisconsin Tissue had approximately quarterly sampling for 1976 through 1978. Most other dischargers had 1 to 10 samples collected over the period from 1974 to 1978. In addition, a few samples were collected in 1983 and are also listed. By 1983, effluent concentration were very low and have negligible impact on PCB loads. As a result, PCB effluent data that may be available from other sources for periods after 1980 were not pursued.

Data collected in the mid-1970s is by far the most important component of the hindcast PCB mass loading calculation. Unfortunately, all of this data was collected after the initial voluntary action by Monsanto to discontinue the use of PCBs in "open uses" that could get into the environment. No data on effluent concentrations during the era of unfettered PCB use (1954 to 1971) was found in this investigation. Effluent information prior to 1971 would provide direct data on the actual ranges of concentrations which could verify the assumptions used in this report. Unfortunately, no PCB concentration data prior to 1971 were located. This was an obstacle to estimating the total loading of PCB to the river and affects the uncertainty of load estimates. For purposes of making hindcast estimates of PCB discharge, it is absolutely best to use data collected as close to 1971 as possible. Given the 3 year half life of office forms suggested by Shade, data beyond 1980 would be of little value and may well increase the uncertainty of hindcasts.

Along with the data on effluent concentrations shown in Appendix C, many other PCB samples were found from the Lower Fox River area. In particular, biota PCB samples as well as sediment and water column samples are presented in the lab books. Although biota data were not transcribed in this document, all sediment and water column samples were added to the spreadsheet shown in Appendix C because they are directly relevant to a model hindcast attempted with the discharge data estimated here. Water column and sediment data collected during the mid-1970s will serve as quantitative validation data for model hindcast simulations.

Some interesting observations can be made with the sediment and water column data. First, the water column data indicates LODs ranged between 0.05 and 0.3 ug/l (50 to 300 ng/l) which are high by today's standards but, were none-the-less, sufficient to detect water column concentrations during this era. Over fifty (50) samples are reported with about 1/3 showing detectable PCB levels, especially in the Green Bay area. All samples upstream of Menasha and Neenah are at or below LOD. Reported values range from 0.08 ug/l at Rapide Croche Dam on 12/17/74 to a high of 0.85 ug/l at Fritz Park in Little Lake Butte des Mort on 2/28/77 with the average concentration ranging from 0.11 ug/l to 0.17 ug/l depending on how

LODs are defined (<LOD equals 0 or <LOD equals LOD respectively). While these concentrations are higher than the range observed during the 1988-1990 Green Bay Mass Balance Study, they are higher only by a factor of two to three. This indicates that river concentrations declined somewhat from 1973 to 1989 as one would expect, but by a much smaller amount than simple exponential decay would suggest should have occurred. These data should be compared to those gathered by Marti and Armstrong in the early 1980s as well as the Green Bay Mass Balance Study data to further verify water column trends. As stated above, this water column data provide data to evaluate the performance of hindcast simulations using PCB transport and fate models for the Lower Fox River and Green Bay.

Sediment data also were also collected and are shown in the Appendix C. It is not known how these samples were collected or the precise locations of these samples. However, it is most likely that samples during this period were gathered with some type of sampling dredge such as an Ekman or Ponar sampler since this was common practice and equipment available to DNR personnel at the time. Samplers of this type grab surface sediments usually over the top 5 to 10 centimeters of depth. It is safe to assume that the reported samples represent only the surface layer in the sediments. Average concentration reported in this data is 8.6 ppm and only a few of the more than 50 samples exceed 20 ppm. This contrasts with recent findings in several deposits throughout the river that contain areas exceeding several hundred ppm (up to 700 ppm immediately downstream of Fort James-West)[1]. Sediment core samples also reveal that high concentrations persist for many centimeters through the sediment column, indicating it took some time to deposit these layers.

The average concentration in the early sediment samples is only about 9 ppm and only two of the 52 samples exceed 30 ppm (72 ppm in a POTW plume and 61 ppm in P.H. Glatfelter Company's plume). The average concentration of 8.6 ppm is again only about a factor of two or three above that observed as recently as 1995 below DePere. Further exploration of these data is warranted to determine as much as possible regarding sample locations and sample collection methodologies. This data will also be very useful, although more qualitative, comparison data for hindcast simulations using PCB transport and fate models for the Lower Fox River and Green Bay.

A few analyses of paper products are also documented in the lab books. These analyses were of common paper forms including carbonless copy paper, newspaper and paper towels during the 1974 to 1975 period. PCB concentrations in the paper products ranged from less than detect (LOD of 100 ppb) to 7500 ppb of Aroclor 1242. These values are well within the range of PCB concentrations found in paper products by other labs. It was not indicated when these paper products were manufactured. However, this certainly shows that various paper products contained significant PCB concentrations well after the voluntary end of PCB use in NCR Paper in 1971. Recycle of these paper products containing PCBs and post-consumer recycle operations that received general waste paper where small amounts of NCR Paper were present were two of the principle ways pathways by which PCBs were discharged to the Lower Fox River after 1972.

It should be noted that NCR Paper manufactured with PCBs contained up to 3.4% PCB by weight (34,000 ppm). During the period of NCR Paper manufacture using the PCB-containing emulsion, direct recycle of broke was likely the most significant pathway of PCB release to the river. Detailed knowledge of broke use would permit the most precise estimates of PCB discharge histories for most paper mills. Unfortunately, little direct information regarding broke use was available to the Department. In the absence of precise information, broke use was distributed among mills as a function of deink paper production to estimate PCB loads. Anecdotal information exists to support this range of broke usage. The broke distribution process and supporting anecdotal information are presented in the next section.

[1] During periods of extended PCB deposition, high concentrations must have existed at the sediment surface. One then has to ask, why are these high concentrations not observed in the available data from the 1970s collected just after the highest PCB discharge period? If settling of high concentration PCB solids followed by burial with more recent "cleaner" sediment was the primary mechanism causing decreasing concentrations of PCB to be observed in all media of the Fox River today, then it follows that surface sediment concentrations in the hundreds of ppm should have been observed during or just after the period of highest discharge of PCB in at least some of the 52 sediment samples taken. The fact that this condition was not observed is at least a qualitative indication that long-term sediment transport patterns very likely include episodes of pronounced net particle movement from the sediments to the water column.

7.0 PCB Load Calculation Hindcasting

For purposes of this report, three pathways of release to the river were considered for PCBs used in the production of NCR Paper. These three pathways are: 1) **PRODUCTION** releases of PCBs during the manufacturing process (primarily at the Appleton Papers - Appleton Coated Papers Mill); 2) direct **BROKE** usage of NCR Paper broke and converter trim derived from manufacturing and printing process and to deinking mills in the Fox Valley and elsewhere; and, 3) **WASTEPAPER/SECONDARY FIBER** recycling which includes post-consumer paper that contains some NCR Paper forms or use of a secondary fiber source that contains detectable PCB. These three pathways were investigated to determine the total PCB discharge and annual load at each facility that may have conducted any of these three types of activity during the period of 1954 to 1997.

Losses of PCB during NCR Paper production were not measured directly during the period when PCBs were used. However, estimated ranges of losses can be made on the basis of total PCB emulsion used in coating operations. It is known that some losses occur in the NCR Paper coating operations particularly during equipment cleanup and production change overs (as they do in any paper coating operation). It is also known that the Appleton Coating Mill discharged to the Appleton POTW.

Discharges from facilities using NCR Paper broke were likely very significant and are expected to be the single largest vector for PCBs to reach the river. Estimates of the quantity of NCR Paper broke produced per year set bounds on the mass of PCBs that may have been discharged by this route. Knowledge of broke movement between mills is incomplete and was therefore estimated by distributing the broke available between mills capable of using it as a function of deink paper production.

In the final category, recycle of post-consumer wastepaper and secondary fiber usage were combined. Data are available that show most types of paper products manufactured during the 1960s and 1970s contained significant (i.e. much greater that analytical limits of detection) concentrations of PCBs because they were manufactured in part with fiber derived from NCR Paper broke, wastepaper, or secondary fiber containing PCBs. (See "PCBs Involvement In The Pulp and Paper Industry", Carr, Durfee and McKay, EPA 560/6-77-005) In addition, post-consumer wastepaper could contain some NCR Paper thrown out with discarded files and papers with inks that contained PCBs. All of these sources contributed to the presence of PCBs in nearly all paper products and added to PCB releases to the environment. This route is well documented since PCB effluent measurements occurred during part of the relevant time period (1974-1978) when PCBs were still prevalent in the paper fiber supply. Hindcast PCB loads for the "WASTEPAPER" category do not include discharges due to production or direct broke usage. Without documentation that sources of wastepaper/secondary fiber were free of PCBs, it was assumed that the potential for PCB discharge exists for any facility that used these fiber sources.

PCB Release During PRODUCTION (Release Type 1): NCR Paper production occurred in the Fox Valley primarily at Appleton Papers- Appleton Coated Mill. A second mill located in Dayton, Ohio also produced NCR Paper. NCR split PCB emulsion to the two mills. An initial assumption was that about 50% of the PCB emulsion manufactured by NCR went to Appleton Coated Papers with the remainder going to a mill in Ohio. (Dennis Hultgren, Pers. Comm.) The availability of NCR Paper production data from Appleton Paper mills (Coated Papers and Locks Mill) along with data on total emulsion and PCB use by NCR allowed a more accurate calculation of the PCB split between the two competing mills manufacturing NCR Paper during this period. Data indicates that the yearly amount of emulsion NCR delivered to the Appleton mills ranged from 26% in 1954 to a high of 71% in 1969. The overall usage indicated that just over 65% of the emulsion was used at the Appleton Coated Papers facility. A few other facilities also began or experimented with the manufacture of PCB-based carbonless copy paper around 1965. However, total production of carbonless copy paper at these facilities was small compared to Appleton Coated and the Ohio mill (Dennis Hultgren, Pers. Comm.) and therefore does not impact the estimated quantity of emulsion used at Appleton Coated Papers.

Total emulsion production reported by NCR and total PCB used in the manufacture of the emulsion allowed calculation of the PCB content of the emulsion. The percentage of PCB in the emulsion varied somewhat,

but was consistently at or near 57% PCB by weight. These figures allowed calculation of the total PCB movement into the Fox Valley. It is estimated that between 29.6 to 30.2 million pounds (13.5 to 13.7 million kg) of PCBs came to the Fox Valley in the emulsion. All of this PCB was Aroclor 1242. Assuming a 1% to 5% range of loss during production results in 28.7 million pounds coated on paper and broke with 279,000 to 1,450,000 pounds lost to sewers during production. Of the PCB applied as coating, most was contained in product (NCR Paper) with several percent contained in broke. Data supplied by Appleton Papers was used to estimate the percentage of production that was sold as broke and is the basis for estimates of release of PCBs to the river from use of NCR Paper broke.

The estimates reported rely the mass of PCB used and the total NCR Paper production to calculate the fraction by weight of PCB in NCR Paper. Such an estimate was available in a letter from Walter Spearin of NCR to James Haney of Bergstrom Paper, in 1976. In this letter, the data in Table 2 were reported.

Table 2: Ratio of Aroclor 1242 Consumption for Carbonless to NCR Carbonless Estimated Production.

Year	(B) Aroclor 1242 Consumption (Thousand Pounds)	(C) NCR Paper Estimated Production (Thousand Pounds)	(B) * 100 / (C) PCB Content (Percent)
1957	587	20,020	2.9
1958	779	26,528	2.9
1959	1,019	34,868	2.9
1960	1,149	41,406	2.8
1961	1,643	51,008	3.2
1962	1,953	59,416	3.3
1963	2,281	69,166	3.3
1964	2,705	83,524	3.2
1965	3,489	103,710	3.4
1966	4,246	121,188	3.5
1967	4,355	139,024	3.1
1968	5,801	166,500	3.5
1969	6,278	174,672	3.6
1970	6,611	183,152	3.6
1971	1,266	177,954	--
Total: 1957-1970	42,896	1,274,182	3.4
1957-1971	44,162		

Note: Data from Table 2 has often been quoted in literature indicating that a total of 44,162,000 pounds of PCBs as Aroclor 1242 was used for NCR Paper production. This figure does not include 1954 through 1956. Extrapolation for these early years puts the total PCB usage at 45,200,000 pounds of Aroclor 1242.

The percent PCB by weight reported in Table 2 was combined with data supplied by Appleton Papers on NCR Paper production at Appleton Coated and Locks mills to estimate the amount of PCB used in the Fox Valley for NCR Paper. This in turn allowed the calculation of the split of emulsion going to Appleton versus the other mill in Ohio.

Production losses of emulsion may not have been taken into account in Table 2 when calculating the percent of PCB by weight in NCR Paper. Appleton Papers estimated production losses to be a small percent of total emulsion use. PCBs lost during production entered wastewater discharge streams and would not be applied to paper. This would decrease the PCB applied to the paper (column B) resulting in a slight decrease in the percent of PCB in the product. It cannot be determined whether this adjustment is appropriate for the data in Table 2. Therefore, the reported values shown in Table 2 were used without adjustment. Adjustment to account for production losses, if applicable, would affect both the production

and broke related discharges calculated and reduce those numbers, but only by a maximum of 2%. PCB discharge from wastepaper/secondary fiber recycle would not be affected.

Application of the data in Table 2 resulted in an estimate of PCB discharge to the City of Appleton sewer system from Appleton Coated Papers. This loss was calculated from data on PCB use by Appleton Coated Paper by year assuming a small fraction of the PCB emulsion was lost to the sewers during production. Estimates of losses to the collection system range from approximately 1% to 5%. This range of production loss estimates was developed from information prepared by representatives for Appleton Papers as well as wastewater treatment information Appleton Papers provided to the City of Appleton during the 1970s. Applying production loss factors from 1% to 5% results in a significant discharge of PCBs to the Appleton sewer system, ranging from 279,000 to 1,450,000 pounds (126,300 to 658,200 kg) of PCBs respectively between 1954 and 1971. A value of 853,000 pounds (386,600 kg), or a 3% loss rate, was used for subsequent calculations.

The selection of the production loss rate at the Appleton Coated Papers mill is a key determinant in the magnitude of cumulative PCB discharges to the Lower Fox River from this facility. Selection of a 3% production loss rate was based on numerous considerations and was not selected simply as a "mid-range" value. First, it is important to recognize that Appleton Papers had strong economic incentive to minimize production losses of the PCB-containing emulsion used to produce NCR Paper. The emulsion was expensive compared to typical paper coating materials such as clays and starches and the raw paper stock itself. Based on information presented by representatives for Appleton Papers, the emulsion may have represented up to 60% of the production cost of NCR Paper. Given the competitive situation between Appleton Papers and Mead Paper (the other producer of NCR Paper) created and maintained by NCR, it was unquestionably in Appleton Papers' best economic interests to minimize PCB emulsion losses. Additional information presented by these representatives suggested that the overall production loss rate may have been between 1% and 2%. However, production loss rates as little as 1% to 2% are not well supported.

The central components to the production loss rate calculation presented by representatives for Appleton Papers critically depended on a series of unverifiable assumptions. Two critical, but unverifiable, assumptions were the frequency and magnitude of coating machine rinse-up and wash-down events and the trapping efficiency of small settling basins (honey tanks) at the Appleton Coated Paper mill. The analysis presented tended to understate the potential for losses as a result of equipment cleaning/maintenance operations while also overstating the likely particle retention capability of the honey tanks.

The analysis was also in direct conflict with other information regarding wastewater discharges to the sewer system prepared by Appleton Papers. Appleton Papers routinely provided information on the magnitude of discharges to the city sewer system to the City of Appleton for the purposes of computing sewer service charges. These sewer service charges represented a large cost to Appleton Papers that was clearly in the company's best economic interests to minimize. In computing sewer service charges, which were over $10 per 100 pounds of BOD_5 and solids discharged (combined), Appleton Papers routinely reported a 5% production loss rate. It seems highly unlikely that Appleton Papers would have routinely overestimated its discharges to the city sewer system and knowingly incurred larger service charges, especially given its clear economic interests to minimize costs. It should be noted that the 5% loss rate also included losses from products that did not utilize the PCB-containing emulsion and therefore may not have been subject to the same pressure to minimize losses as were NCR Paper products. For this reason, the 5% value may overestimate the loss rate for NCR Paper products. In light of this information, a loss rate of more than 2% but less than 5% was believed to best characterize emulsion losses and a 3% production loss rate was selected.

Finally, a small amount of PCB emulsion was used at the Appleton Papers Locks mill in tests of NCR Paper production. For purposes of these calculations, 2% of the emulsion used in the Valley during the years 1969-1971 was assumed to have been used at the Locks mill based on discussions with mill representatives. A 3% production loss rate was assumed for the Locks mill. All of this PCB loss is assumed to have been discharged to the river through the savealls on the Locks mill waste stream.

PCB discharges attributable to production losses from the Appleton Coated Paper mill are affected by the removal efficiency and magnitude of bypasses at the Appleton POTW. TSS removal was considered a surrogate for PCB removal. While it is worth noting that limited anecdotal information suggests that the PCB-containing capsules on NCR Paper flocculated readily under quiescent conditions, potentially increasing PCB removal efficiencies, the validity of this information could not be confirmed.

Bypassing from the Appleton POTW system included both collection system bypasses and treatment plant bypasses due to inadequate treatment capacity and severe inflow problems. Mill representatives believe that collection system bypassing did not affect the Appleton Coated Papers discharge since it joined a main interceptor shortly after leaving the Appleton Coated Plant. However, a report by Consoer, Townsend & Associates revealed the existence of a bypass at the Green Bay Road crossing where Appleton Coated wastes crossed the river on the way to the POTW. Furthermore, this bypass location discharged up to 2 MGD during a wet weather flow study in January of 1973. In addition, bypassing at the Appleton POTW was significant during the 1960s and 1970s, and resulted in reduced removal efficiencies at the plant. The method used to estimate bypassing is explained in Section 5.0 under Municipal Bypassing Summary. The collection system and treatment plant bypass was particularly important for calculating PCB releases from the Appleton POTW.

In summary, a production loss rate of 3% was applied at Appleton Coated and Appleton Locks. Taking into account treatment on each waste stream resulted in discharges of PCB to the Lower Fox River due to **PRODUCTION** of NCR Paper of 122,450 kg (270,000 pounds).

PCB Discharge Due to NCR Paper BROKE and Converter Trim Use (Release Type 2): The majority of PCB discharged to the Fox River was the result of NCR Paper broke and converter trim use. Broke considered in this report includes off-quality product and trim generated at the Appleton Papers-Coating and to a lesser extent the Combined Locks mill. Converter trim includes unused papers and trim from NCR Paper as forms were made. It is estimated that several million pounds of PCB were tied up in NCR Paper broke and converter trim. Use of this broke/converter trim by deinking mills almost certainly released a great deal of the PCBs to the wastewater stream of the mill. Releases of only a small fraction of this PCB mass results in more discharge of PCB to the Lower Fox River than the total discharge from the other two pathways combined.

Releases of PCB from the use of broke and converter trim depend on nine primary factors. These are:

1. Amount of Broke produced by Appleton Papers;
2. Percent by weight of PCB on the Broke;
3. Fraction of Broke from Appleton Papers used in the Fox Valley;
4. Amount of Converter Trim produced;
5. Fraction of Converter Trim used in the Fox Valley;
6. Distribution of Broke and Converter Trim;
7. Partitioning of the PCB onto the deinked/recycled fibers versus the wastewater stream;
8. PCB removal during wastewater treatment of deinking/recycling waste stream; and
9. Fiber loss (with partitioned PCB) during paper making using the deinked/recycled fiber.

Generation and Concentration of NCR Paper Broke: Broke produced at Appleton Papers is well documented for 1967 through 1970. Broke generation rates were very stable and can be extrapolated for earlier years. Broke consisted of trim from rolls of coated paper as well as off-grade product that could not be otherwise sold. To minimize edge curl, Appleton Papers did not coat paper to the edge of the roll. Mill representatives estimate that only 62.5% of the broke produced was coated based on an analysis of coating and trimming operations. As a result, the PCB content of NCR Paper broke is expected to be less than the PCB content of fully coated products as presented in Table 2. Assuming that the broke generated consists mainly of roll trim and that only 62.5% of roll trim area was coated with the PCB containing emulsion, the PCB content of the broke would be reduced to 2.1%. Broke that included significant quantities of fully coated products would be expected to have a somewhat greater PCB content.

Movement of NCR Paper Broke: Most, if not all, NCR Paper broke produced by Appleton Papers was likely deinked and used in the Fox Valley. Several factors support this conclusion. Substantial deinking capacity was available in the Valley. One estimate placed Fox Valley deinking capacity at nearly 33% of the total deinking capacity available in the U.S. In comparison, the total amount NCR Paper produced would have required only about 1% of the deinking capacity in the Valley. Given the strong local demand for broke (of any type) and that shipping costs would have made it less economically attractive to ship material to distant mills, it is reasonable to conclude that most, if not all, NCR Paper broke from Appleton Papers was consumed in Fox Valley.

Despite the strong demand for broke in the Valley, it is possible that a small amount NCR Paper broke produced by Appleton Papers was nonetheless shipped to deinking facilities outside the Fox Valley. However, it is important to note that Appleton Papers was not the only source of NCR Paper broke. Mead Paper, located in Dayton, Ohio, also produced NCR Paper and broke as well. The same economic factors that might have permitted broke produced by Appleton Papers to leave the Fox Valley would have also permitted broke produced by Mead Paper to enter the Fox Valley. Therefore, it is possible that a small amount NCR Paper broke produced by Mead Paper may have been shipped into the Fox Valley.

For these reasons, it was assumed that the quantity of NCR Paper broke generated in the Fox Valley was equal to the quantity of broke consumed in the Fox Valley. This assumption was used to calculate potential PCB discharges attributable to broke use. No specific data has been found which refutes this assumed movement of broke. In making this assumption, it was not necessary to determine the precise origin of all NCR Paper broke consumed in the Valley since, for all practical purposes, broke generated by Appleton Papers would have been indistinguishable from broke generated by Mead Paper.

Movement of NCR Paper Converter Trim: Converting operations exist in numerous locations both inside and outside of the Fox Valley. Converter (printer) trim generation rates typically range from 10% to 15% according to A.D. Little, "Analysis of Demand and Supply for Secondary Fiber in the U.S. Paper and Paperboard Industry". While typical for the printing industry, these trim generation rates are likely somewhat lower than what might be expected from NCR Paper converting operations as a consequence of the expected difficulties handling papers with pressure sensitive inks that readily smudge. Mill representatives estimate that NCR Paper converting operations might routinely generate 20% trim. However, quantitative documentation of NCR Paper converter trim generation rates was not found. Therefore, to avoid potentially overestimating the quantity of converter trim available, a 10 % converter trim generation rate was assumed. It was also assumed that 33% of the trim returned to the Fox Valley for deinking/recycle since 33% of the total deinking capacity in the U.S. was in the Valley. Because converter trim was expected to have been generated from fully coated paper products, this trim was assumed to contain the full PCB content of coated paper as shown in Table 2.

Who Used NCR Paper Broke and Converter Trim: Use of NCR Paper broke and converter trim apparently required deinking, since the emulsion capsules contained ink. It is not known if certain types of NCR Paper could have been used without deinking or with only limited deinking. In the production process, paper with the capsules coated on the back side (coated back or CB paper) only contained the colorless dye, but did not contain the reaction chemicals. This paper may have been useable with only limited or no deinking for at least some types of production. Paper coated with both materials (coated front and back or CFB and self contained or SC paper) probably required deinking for any use since both the reaction chemicals and dye were contained on them.

Five paper mills had deinking capabilities during the period of time NCR Paper was produced. They are P.H. Glatfelter, Wisconsin Tissue, Riverside (after 1970), Appleton Papers - Locks Mill (up to 1966 only) and Fort James-West Mill (Fort Howard). The deinking capacity of these mills far exceeded the amount of NCR Paper broke estimated to have been available. In fact, NCR Paper would have used only about 1% of deinking capacity in the Valley. Furthermore, the deinking capacity of even the smallest mill exceeded the entire NCR Paper broke production in even the highest year of production.

Three other paper mill may have been able to utilize small quantities of NCR Paper broke with either limited or no deinking. These include producers of paperboard and corrugated paper products. They

include U.S. Paper-Depere, U.S. Paper-Menasha and Green Bay Packaging. All three of these mills used substantial secondary fiber but did no deinking. Secondary fiber sources reported by these mills included several types with PCB concentrations (see Carr et. al.). In the case of U.S. Paper, some sources could have included small amounts of NCR Paper discarded as office waste even though U.S. Paper instructed personnel to reject shipments that contained NCR Paper. However, it was assumed that none of these mills directly used NCR Paper broke or converter trim.

Three mills volunteered that they did in fact use NCR Paper broke. These mills include Fort James-West (a significant amount 1967-1971), P.H. Glatfelter (a small amount here and there), and Riverside (1971 only). Unfortunately, total broke use based on these anecdotal estimates amounts to less than 20% of the available NCR Paper broke. Consequently, it was necessary to devise an approach to divide the use of NCR Paper broke over the relevant period from 1954 through 1971. This was performed by assigning broke usage in direct proportion to the deinking production reported at the mills. Broke usage was apportioned based on 100% of reported deinking production for the five deinking mills. This was done on an annual basis for the entire period. The production data reported in Section 5 of this report was used for the five deinking mills.

The distribution of Broke and Converter Trim using this approach resulted in two facilities receiving almost 90% of the material (Ft James-West and P.H. Glatfelter), one other facility receiving 10% (Wisconsin Tissue), and the remaining five facilities combined receiving less than 1% of the total (Appleton Papers-Locks Mill, Riverside Paper, U.S. Paper-Menasha, U.S. Paper-DePere and Green Bay Packaging). This distribution of broke was used to develop PCB discharge estimates attributable to broke usage at these eight facilities.

Partitioning of PCB to Product: A major factor affecting discharges of PCBs from broke (or any fiber source) is the partitioning of PCBs to fibers during the deinking process. Two reports examining PCB partitioning to paper products were found but have somewhat conflicting results. The first report was by Richard B. Valley (1990) entitled "Sources of PCB Contamination in the Kalamazoo River" (prepared for Georgia Pacific Corporation. The Valley report assumed that only 10% of the PCBs entering a deinking plant are incorporated into products. Valley further assumed that 50% of the PCBs entering a boxboard plant are incorporated into products. This study was not considered rigorous, however, since the incoming mass of PCB was not established. The second report was by Carr, Durfee and McKay (1977) entitled "PCB Involvement in the Pulp and Paper Industry" (EPA 560/6-77-005). The Carr et al. report was based on a mass balance for the paper industry. Carr et al. concluded that 75% of the PCBs entering paper mills are incorporated into products. While the Carr et al. report was considered more rigorous, the mass balance presented was applied on an industry-wide basis rather than for individual paper mills. Despite these differences, both studies nonetheless indicate that boxboard mills incorporate more PCBs into products than do deinking operations.

One factor that may affect PCB retention in products concerns the nature of the microcapsules in the emulsion used to make NCR Paper. PCBs in NCR Paper emulsion were encapsulated in a waxy matrix. These waxy microcapsules are believed to have been far less hydrophobic than PCBs and therefore less likely to be retained in products. Deinking plants repeatedly wash fibers during recycling to retain higher quality fibers for products. If the microcapsules ruptured during recycling, the formerly encapsulated PCBs would be released, partition to fibers (as a function of PCB hydrophobicity), and therefore be more readily retained in products. If the capsules remained intact, deinking and repeated fiber washing would remove the capsules and the still encapsulated PCBs as this process does other solids and fillers. By contrast, boxboard plants retain the maximum possible quantity of fiber in products with the minimum possible fiber washing. As a result, boxboard plants would be more likely to retain PCBs in products whether or not the microcapsules ruptured during recycling. The consensus of experts is that the microcapsules would remain intact during recycling. This suggests that less than 75% of the PCBs entering a paper mill would exit in product. In light of these considerations, PCB partitioning to products was assumed to be in the range of 25% to 75%.

The appropriateness of this range of partitioning values was confirmed by calculating the concentration of PCBs in the fiber at each mill. This was computed by dividing the weight of PCB retained in the fiber for various assumed partitioning factors, dividing this quantity by the total mill production of deinked paper,

and converting to parts per million (ppm). Numerous observations are available describing PCB concentrations in paper during the period 1965 to 1980. These observations are from chemical analyses of archived wastepaper stock samples. Most measurements were in the range of 0.10 to 20 ppm. A very few measurements exceeded 100 ppm. It should be noted that these data include mostly wastepaper stock rather than products from deinking/recycling mills. Consequently, the partitioning factor was selected such that the PCB concentration in the fiber would not exceed a few 10s of parts per million. This factor was very important in the overall mass balance of PCBs for a mill, since PCBs incorporated into products directly reduced the PCBs calculated to be in the discharged waste stream.

On the basis of the predicted product PCB concentrations, 25% partitioning to product fiber was most appropriate for the five deinking facilities. However, since PCB concentrations in final products are not available, results are presented for both 25% and 75% partitioning. This has a dramatic impact on the total discharge of PCBs to the river due to **BROKE** and **CONVERTER TRIM** use and causes these discharges to range from 176,450 kg to 71,750 kg, respectively (higher partitioning to product results in less PCB in wastewater). This range occurs when all deinking and nondeiking mills use the same partitioning factor in the calculations.

Removal of PCB During Waste Treatment: The remaining two factors are unique to each mill and are discussed as part of the mass balance of broke and converter trim PCB for each facility. The descriptions below detail the assumptions used and the discharge to the river from each facility as the result of broke and converter trim usage. Discharges of PCB due to production of NCR Paper or wastepaper/secondary fiber recycle add to the amounts discussed below. Results are shown assuming 25% partitioning to product. Results shown in parenthesis assume 75% partitioning.

Fort James-Green Bay West: This facility is assumed to have received over 63% of the broke. This facility operated in essentially the same treatment mode from 1951 to late 1970 covering the relevant time period. Deinking mill wastewater was treated in settling lagoons. Data from 1961 to 1969 indicate 92% solids removal efficiency. Paper mill wastewater was treated only with savealls and directly discharged. Overall TSS removal considering both waste streams was 78%. Using 25% (to 75%) partitioning and 92% removal of PCB on deinking waste and 0% removal from the paper waste stream results in 61,500 kg (33,000kg) of PCB discharged due to broke use. At 25% (to 75%) partitioning, estimated PCB concentrations in products ranged from 9,000 to 101,500 ppb, (27,000 to 304,500 ppb) which is somewhat higher than the data range. However, to lower the product concentrations would have required a lower partitioning value (below the reported range) and would also result in higher total discharge. Of the 61,500 kg discharged, about 4,700 kg (14,100 kg) were due to fiber losses in the paper waste stream. Fiber loss averaged just under 2% according to data based on TSS discharged per ton of production.

P.H. Glatfelter: This facility is assumed to have received over 25% of the broke. Treatment consisted of primary clarification and chemical addition. Primary clarification was used throughout the relevant period with solids removal averaging about 75%. It was assumed that both deinking and paper wastewater were treated in the clarifier and removal efficiency of the clarifier was assumed to be 75%. Partitioning of PCB to fiber was set at 25% (to 75%). Concentrations of PCB on product under the partitioning assumption and broke use rate would have ranged from 23,700 to 230,000 ppb (71,000 to 690,000 ppb). Again this is considerably above the reported ranges, however, reducing the concentration would require a lower partitioning value and would have increased the overall PCB discharge. Total calculated PCB discharge due to broke usage was 71,500 kg (23,800 kg).

A mass balance was constructed to estimate the total quantity PCBs removed by the clarifier and removed to Arrowhead Landfill. Using the assumed values for wastewater treatment solids removal efficiency of 75% results in 354 million kg of sludge (dry weight) removed to Arrowhead Landfill. Using this approach, and PCB partitioning of 25% (to 75%), the sludge is estimated to have contained 220,800 kg (78,300 kg) of PCBs. PCB concentrations in the sludge would have ranged from 100 to 1475 ppm (35 to 525 ppm) dry weight. These values compare favorably with observations for the Arrowhead Landfill from 1980 which ranged from 1 to 590 ppm. Losses from the landfill to the river occurred due to the landfill being exposed to wind-wave erosion and runoff during the time it was being filled (1951-1975). A range of 5% to 20% material loss rates (and PCB associated with it) was assumed resulting in a range of 11,000 kg to 44,150 kg

(3,900 to 15,650 kg) entering the river from the landfill. A 5% material loss rate from the landfill was assumed, resulting in 11,000 kg (3,900 kg) of PCB entering the river.

Wisconsin Tissue: This facility is assumed to have received over 9% of the broke. Wisconsin Tissue discharged to the Neenah-Menasha POTW during the entire period when NCR Paper broke was used. As with other deinking mills, a 25% (to 75%) partitioning factor was assumed. This results in predicted PCB concentrations on product of 13,500 to 101,500 ppb (39,900 to 303,900 ppb). Under these assumptions, 106,000 kg (35,300 kg) of PCBs were discharged to the Neenah-Menasha POTW due to broke use. PCB discharges from the Neenah-Menasha POTW were controlled by the treatment plant removal rate and the amount of raw wastewater bypassing the plant due to inadequate sludge handling facilities. The Neenah-Menasha POTW was a primary treatment plant until 1967 when secondary treatment went on line. TSS treatment removal was available for most years and ranged from 58% to 82% for primary treatment and 62% to 95% (average 93%) after secondary went on line in 1967. Bypassing ranged from 1% to 35% of total flow averaging about 10% between 1954 and 1971. Total discharge of PCB from the Neenah-Menasha POTW due to broke usage at Wisconsin Tissue was 30,600 kg (10,200 kg).

Appleton Papers-Locks Mill: This facility is assumed to have received 0.05% of the broke. Appleton Paper-Locks Mill had deinking operations through 1966 after which deinking was discontinued. It is unclear whether the deinking works at this facility (which featured a simple, single-stage bleaching process) could process significant quantities of NCR Paper broke or trim. The purpose of distributing a very small quantity of the available broke to the Appleton Paper Locks Mill was simply to account for *the potential* that incidental quantities of NCR broke may have occasionally entered into the fiber furnish of this facility. Treatment at the facility during the 1954 to 1971 period consisted of savealls. Primary treatment was not installed until 1972, well after the period of broke use. Consequently, the solids removal efficiency was assumed to be 0%. As with other deinking facilities, it was assumed that 25% (to 75%) of the PCB partitioned to the fiber resulting in a range of concentration on the product of 40 to 260 ppb (110 to 790 ppb). The resulting calculation was that 550 kg (180 kg) of PCB entered the river as a result of broke use and minimal treatment.

Riverside Paper: This facility is assumed to have received 0.1% of the broke. Riverside Paper began deinking in 1971, just as PCB use in NCR Paper was being discontinued. Process water discharges to the Appleton POTW were not reported to have begun until 1979 (but may have begun as early as 1973), well after the period of broke use. Riverside Paper did not have primary or secondary treatment, the solids removal efficiency was assumed to be 0%. As a deinker, a 25% (to 75%) PCB partitioning factor was assumed. Under these assumptions, the estimated final product PCB concentration was 9000 ppb (27,000 ppb). Total discharge from Riverside Paper attributed to broke use was 1090 kg (365 kg).

Remaining Mills: U.S. Paper-Menasha, U.S. Paper-DePere and Green Bay Packaging are the three nondeinking mills assumed to have received a very small quantity of NCR Paper broke. Together, these mills are assumed to have collectively received less than 1% of the NCR Paper broke. This represents incidental quantities of NCR broke (or trim) that may have occasionally entered into the fiber furnish of these facilities. It is worth noting that although records exist documenting that these facilities accepted secondary sources of paper fiber, no clear information exists to suggest that these mills would have routinely accepted NCR broke. The central purpose of distributing a very small quantity of the available broke to these facilities was simply to account for *the potential* that incidental quantities of NCR broke may have occasionally entered into the fiber furnish of these three facilities. A 75% PCB partitioning factor at these mills was assumed as a result of operational practices designed to maximize fiber use. Calculated discharges dues to broke from these three facilities collectively amounted to less than 600 kg.

In summary, distributing the available broke, applying the 25% partitioning factor to deinking mills and the 75% factor for nondeinking mills, and taking into account treatment on each waste stream as described above resulted in discharges of PCB to the Lower Fox River due to **BROKE and CONVERTER TRIM** of 176,450 kg (71,750 kg).

PCB Discharge from WASTEPAPER/SECONDARY Fiber Recycle and Deinking Operations (Release Type 3): Potential PCB releases were estimated for each discharger identified in Table 1 that utilized any portion of recycled fiber in its operation. "Recycle" in this context includes any secondary fiber processing as well as deinking of pre and post-consumer wastepaper (post-consumer wastepaper may contain some discarded NCR Paper). By 1968, PCBs were found in nearly all paper products. Observed PCB concentrations in wastepaper ranged from 10 ppb to more than 150,000 ppb, with average concentrations from 100 ppb to 200 ppb. PCB concentrations of this magnitude were found in all types of paper, including both pre- and post-consumer secondary fibers. Any facility that included secondary fiber sources in their fiber furnish had at least the potential to discharge PCBs.

Paper mills typically have the ability to reuse internally generated broke. Most mills would occasionally purchase secondary fiber or pulp from other mills to supplement their fiber supply. These materials would not need to be deinked prior to use. Therefore, the list of mills that could have potentially released PCBs through the use of secondary fiber is larger than the list of deinking mills. PCB discharges from this activity would be small compared to the deinking of NCR Paper broke and converter trim. This is because the average PCB content of wastepaper (100 to 200 ppb) was more than 100,000 times smaller than the PCB content of NCR Paper broke. The quality of the end product determined what type and how much of various fiber sources could be used at a particular mill. High quality white bond paper required a higher grade of fiber than paperboard or box cores that could tolerate lower grades.

Finally, deinking operations handled pre and post-consumer wastepaper that required deinking to be useable. As previously noted, the paper stream contained significant concentrations of PCBs incorporated into the fiber as a result of PCB use in NCR Paper and recycling of these products. In addition, post-consumer wastepaper contained a small amount of discarded NCR Paper. Walter E. Spearin of NCR, in a letter to James S. Haney of Bergstrom Paper, made a rough estimate of NCR Paper released to the environment as a result of the destruction of office files. Haney referred to testimony by Bob Shade before the DNR in which Shade "...concludes that about 7.5% of the office forms paper produced up until 1971 was NCR carbonless paper." He further concluded that about 10% of the total forms paper produced is returned to the environment each year via office file destruction. On this basis, 0.75% of the office waste stream would be NCR carbonless paper. Recalling that the average PCB content of NCR Paper was 3.4% (34,000 ppm as Aroclor 1242), the waste stream returning to the environment would contain 0.026% or 260 ppm of PCBs. (Some deinking mills also recycled NCR Paper broke and converter trim from the NCR Paper production and printing operations. The releases due to NCR broke and converter trim are calculated separately as Type 2 releases for the deinking operations that used NCR broke and converter trim.)

A side board estimate of PCB releases to the Fox River from wastepaper/secondary fiber use can be made by assuming 45,200,000 pounds of PCB (see note Table 2) was used to manufacture NCR Paper, of which about 15% would be contained in production broke, converter trim and production losses. That leaves 38,375,000 pounds of PCB on NCR Paper sold for use. Assuming 10% (Bob Shade estimate) of all office forms eventually return for recycle, 3,837,500 pounds of PCBs would return to deinking/recycling mills. In 1972, the Fox Valley possessed 1/3 of the nation's deinking capacity. It is reasonable to assume that as much as 1/3 of this amount, 1,279,100 pounds of PCBs, returned to the Fox Valley in the form of recycled office paper. Using the previous assumptions of 25% partitioning to product and a weighted-average removal efficiency of deinking mill treatment systems (~90%), an UPPER bound of 95,936 pounds (43,508 kg) of PCBs may have been released to the Lower Fox River from wastepaper/secondary fiber recycle.

During the period of 1973 to 1978, effluent PCB concentrations were measured by the Wisconsin DNR and others. This makes it possible to directly estimate PCB releases from paper mills. However, there is one significant caveat to consider when using this method. Most effluent samples were collected from 1974 to 1977. This is up to six years *after* the end of PCB use in NCR Paper. Shade estimated that 10% of office forms return for recycle each year. Of that amount, 90% of those forms would be from the previous year's production. The remaining 10% of this amount would be from all other years with a three year half-life for office files. Presuming this estimate by Shade was accurate, PCB-containing NCR Paper recycled in office files should have decreased rapidly after 1971 when PCB use in NCR Paper was discontinued. Therefore, effluent sampling in 1974 to 1977 may have measured only the tail end of the main recycling of NCR Paper.

If true, back extrapolations using existing PCB effluent data would likely substantially underestimate PCB releases due to wastepaper/secondary fiber recycling. As a result, these estimates may represent a lower bound for this type of PCB release.

It should be noted that most paper mills along the Lower Fox River obtained their water supply from the river. As presented in Appendix C, in the mid-1970s river water contained detectable PCB concentrations. Water column PCB concentrations ranged from no detect to 0.85 ug/l with average concentrations less than 0.2 ug/l. This is consistent with data reported by Carr, Durfee and McKay (EPA 560/6-77-005). PCBs entering a paper mill with intake waters would be subject to water treatment which typically removed 90% of the influent solids (and associated PCBs). PCBs remaining in intake waters would then partition to products (at least 25%) during production and then be subject to effluent treatment (typically 70% removal by 1975). Applying these factors leads to the assessment that intake waters with a PCB concentration of 0.2 ug/l would contribute only 0.0045 ug/l to final effluent PCB concentrations. This is nearly two orders of magnitude below analytical detection limits typically for that period. While factors for individual mills may have varied somewhat from these estimates, based on this analysis it is reasonable to conclude that intake water was not a significant source of PCB detected in mill effluents and was far out-weighed by PCBs in a mill's fiber stream. Therefore, for the purposes of estimating PCB releases to the Lower Fox River, gross discharge estimates are appropriate since intake water contributions are negligibly small in comparison.

Estimates of Type 3 PCB releases from paper mill dischargers required the following data:

+ monthly effluent TSS load from 1954 to 1997;
+ monthly average effluent flow volume from 1954 to 1997;
+ annual average production in tons per day for 1954 to 1997; and
+ effluent PCB concentrations during a period of PCB discharge.

Depending on the facility, the type of production could be expressed as total mill production, deinking production, off-machine paper production, etc. The production values used for these estimates depended on what type of production was most appropriate for representing the PCB release pathway for the facility as well as the completeness of available data.

PCB Release Through Municipal POTWs: Municipal POTWs were a conduit for PCB releases of all three types. Therefore, to determine PCB releases through a particular POTW, it was first necessary to calculate the PCB release from each mill to the collection system. PCB releases to the river were then determined as a function of removal efficiencies at the POTW and estimates of collection system and treatment plant bypassing.

It should be noted that many POTWs had detectable PCB concentrations quantified as Aroclor 1254 reported in the effluent data presented in Appendix C. PCBs were used in many commercial and industrial applications. Higher-chlorinated PCB mixtures such as Aroclor 1248 and Aroclor 1254 were used as electrolytes, cutting oils, hydraulic oils, and as other products and likely account for the PCB detects at POTWs. In contrast, the PCB-containing emulsion used to manufacture NCR Paper contained only Aroclor 1242. It is highly unlikely that PCBs quantified as Aroclor 1254 originated from NCR Paper. Given that PCBs in Lower Fox River sediments are quantified almost exclusively as Aroclor 1242, possible PCB releases attributable to sources other than NCR Paper are essentially negligible in comparison.

Hindcasts for municipal dischargers required some additional data specific to each of the facilities. This included:

+ a list of which and when paper mills discharged to the municipal collection system,
+ all data listed above for each mill discharging to the collection system,
+ some PCB concentrations in the paper mill raw waste sent to the collection system,
+ PCB concentrations in both the raw and final waste streams at the treatment plant[2],

[2] This establishes the percent removal of PCBs by the operating treatment system. If direct PCB removal was not available, TSS removal was substituted as a surrogate for PCB removal.

+ data on frequency and volume of any bypassing at the plant and collection system.

Sections 3.0 through 7.0 of this report detail the data recovered from an exhaustive search of all available records. This record search established either direct data or credible estimates for all information in the above lists that are needed to complete PCB load hindcasts. A PCB hindcast algorithm was then developed to complete the hindcast process. This hindcast method relied on the ratio of TSS discharged per ton of production and then established KEY discharge periods from known PCB discharge data (years when PCB concentrations in the effluent were measured). By assuming TSS is a surrogate of PCB discharge, the TSS to production ratio could be used from the KEY year to ratio PCB discharge for all other years. Results could then be proportioned to production in each year versus the KEY years to get a complete hindcast of PCB discharge. Using this approach, only the treatment efficiency TSS removal at the treatment plant is important and is directly documented by TSS discharge and production records. Neither the exact dates of treatment works startup nor estimates of treatment efficiencies need be known. This represents a more sound method to develop reliable estimates of PCB loads compared to the procedure first applied by the author in prior attempts to estimate PCB releases. The exact steps in the hindcast algorithm are outlined in Table 3 for paper mills and municipal dischargers.

Table 3a: PCB Calculation Algorithms for Wastepaper Recycling: Paper Mills (Method 1.5).

Step	Description
1.	Develop Flow and TSS data for 1954-1997 as continuous monthly averages.
2.	Use reported data where available and interpolate/extrapolate to fill in missing data as needed.
3.	Obtain ANNUAL average production data for each mill 1954-1997. Get production data for all types of production (paper, pulp, deink,etc.).
4.	Find all PCB concentration data and date of data for each source. Gather concentrations from raw, lagoon, clarified, and final treated.
5.	Sort PCB data and use only final effluent data for next steps. (Note that raw data paired with final effluent data can be used to estimate mass trapped in treatment plant and concentrations prior to treatment.)
6.	Line up appropriate Flow and TSS data with each PCB data point.
7.	Use paired Flow and Concentration data to calculate mass discharge as a lb/yr rate.
8.	Group all values from step 7 by year and obtain mean and standard deviation for each.
9.	Use data from step 1 to develop annual average Flow and TSS.
10.	Choose the best set of production data to use for load estimate. Fill in missing production data by interpolation/extrapolation.
11.	Ratio TSS #/day to Production Tons/day to obtain TSS#/Ton Production for each year of 1954-1997.
12.	Inspect results from step 1 and step 8 and decide on KEY YEARS with best PCB data that can be used to hindcast PCB discharge in early years.
13.	Ratio results from step 11 to "average value" from step 11 for KEY YEARS. This develops a ratio by year of TSS/Prod to TSS/Prod for KEY YEARS.
14.	Multiply ratio from step 13 by average PCB mass discharged per year for the KEY YEARS (results of step 8 and 12) and proportion to production in each year versus production in the KEY years.
15.	Multiply results from step 14 by a fiber furnish factor to account for historical production of NCR Paper.
16.	Insert data from step 8 where it exists.
17.	Extrapolate data from '77 to present assuming exponential decay at 0.15/yr. This accounts for the decay of PCB in fiber furnish.

Table 3b. PCB Calculation Algorithms for Wastepaper Recycling: Municipal POTWs (Method 2).

Step	Description
1.	Develop TSS and Flow data as monthly averages for 1954-1997.
2.	Use Method 1.5 to estimate mass contributed to POTW collection system from contributing sources. (Requires all data needed for Method 1.2 for each discharger and concentrations of PCB "discharged to the collection system".)
3.	Sum known sources by year to estimate total "raw" load to POTW sewers.
4.	Make estimate of "raw" load to river based on bypassing estimate.
5.	Estimate % removal for treatment steps from PCB concentration data.
6.	Take result from step 3 and subtract result from step 4 to get input to POTW.
7.	Apply appropriate removal percent for type of treatment to get final loads.
8.	Sum bypassed load and discharged load (step 4 and 7) to get total load.
9.	Insert data based loads for years with concentration data and compare.
10.	Extrapolate from 1977 to present assuming exponential decline at 0.15/year.

Table 3c. PCB Calculation Algorithms for Wastepaper Recycling: Municipal POTWs (Method 3).

Step	Description
1.	If no paper mill sources are present or known, estimate PCB load by Flow only.
2.	Develop Flow data monthly averages for 1954-1997.
3.	Use all PCB concentration data for final effluent with Flow data to get load.
4.	Determine KEY YEARS from inspection of load data from step 3.
5.	Ratio annual average Flow to Flow average in KEY YEARS.
6.	Calculate load for all years based on ratios in step 5.
7.	Extrapolate beyond 1977 assuming exponential decline at 0.15/yr.

The methods described in Table 3 were applied to each discharger to hindcast a total PCB load for each facility. An important factor in the calculations was the PCB content of the fiber furnish entering the mills between 1954 and the present. During the period of production of NCR Paper, PCB concentrations very likely increased. After use of PCB stopped, concentrations would decrease rapidly at first and then more slowly. Two strategies were employed to account for these two events.

The first strategy involved the period before 1970. For this period, it was assumed that PCBs entered the fiber furnish stream to the mills over a period of years. The fiber furnish factor was developed based on data supplied by NCR that indicated the annual mass of PCBs used in NCR Paper production. These data were normalized to 1970 (the year of maximum production using PCBs). A value of 1.0 represented the peak availability of PCBs in the fiber stream. The 1.0 value was continued through 1977. The year 1977 was chosen since this was generally the end of the PCB effluent data period. PCB effluent data were available for the years 1974 through 1977 and were used directly with no additional modification by the fiber furnish factor. The second strategy involved the period after 1977. For the this period, it was assumed that the fiber furnish to the mills would decrease over time as NCR Paper in use gradually decreased and the PCB content of paper being recycled gradually diminished. This was accomplished by assuming an exponential decay applied to the fiber furnish factor beginning in 1978. Several decay rates were tried with the intent of targeting measured effluent loads during the 1988-1990 Mass Balance Study period. A decay rate of 0.15/year was found to give satisfactory results. The PCB mass load from all point sources calculated for the year 1989 using this method was 12 kilograms and is in approximate agreement with Green Bay Mass Balance Study results. The 0.15/year decay rate was used to estimate PCB loads for all dischargers during the years 1978 to 1997. Figure 4 shows a graph of the fiber furnish factor based used to estimate PCB releases attributable to wastepaper/secondary fiber use.

A simple analysis of the appropriateness of the decay rate was performed using data provided by Fort James-Green Bay West on the direct PCB content of wastepaper it received over the years. Figure 4 also shows a comparison to typical PCB paper content and indicates that the decay rate of 0.15/year is

reasonable. It should be noted that by 1978, the mass load of PCBs discharged to the river is quite low compared to the total historical discharge. Even a substantial error in the exponential decay rate projections would have a negligible overall effect on the total mass calculation of PCB discharged to the Fox River for the entire period from 1954 to 1997.

Figure 5 shows the relative growth in NCR Paper production in the U.S. as well as at Appleton Coated Papers. As can be seen, production at Appleton Coated Paper nearly exactly mirrors total production of NCR Paper in the U.S. Figure 6 shows the total amount of PCB emulsion produced at the Dayton, Ohio and Portage, Wisconsin facilities by year. Also shown is the calculated amount of the emulsion that was used in the Fox Valley. A nearly constant two thirds of the emulsion was used by Appleton Coated Papers. Finally, Figure 7 shows the relationship between TSS loading to the river from paper mills and the usage of PCB emulsion in the Fox Valley. As can be seen, all of the PCB emulsion had been used prior to 1972. The timing of recycling of broke and converter trim containing PCB would have closely followed the curve of emulsion usage. It is important to note that essentially all emulsion usage occured before the significant drop in TSS loads between 1970 and 1977. This relationship is important since improved treatment plants were constructed at most mills during the early seventies and resulted in greatly decreased TSS loads. Unfortunately, most treatment plants came into service too late to reduce releases of PCBs from broke and converter trim use or the smaller discharges attributable to wastepaper/secondary fiber use.

These algorithms and strategies were followed for each discharger identified in Table 1 as a potential discharger of PCBs. The results shown in Appendix D lists annual loads for each discharger by year for 1954 to 1997 for all release pathways. PCB calculation summaries are presented in Table 4. In summary, taking into account the PCB content in the fiber furnish as described above resulted in discharges of PCB to the Lower Fox River due to **WASTEPAPER/SECONDARY FIBER** of 14,800 kg.

Table 4a. PCB Calculation Summary By Source: Publicly Owned Treatment Plants (POTWs).

POTW	Contributing Mill	Years Release Type Occurred		
		Production	Broke	Wastepaper/ Secondary Fiber
Neenah-Menasha POTW	Wisconsin Tissue	na	54-97	54-97
	U.S Paper-Menasha	na	rejected at mill	54-97
	Kimberly Clark-Neenah/Badger Globe	na	na	54-97
Menasha East POTW	none known			
Menasha West POTW	none known			
Grand Chute/Menasha West POTW	none known			
Appleton POTW	Appleton Papers-Coated Paper	54-71	na	na
	Riverside Paper Corporation	na	71	54-97
Kimberly and Little Chute POTWs	none know			
Kaukauna POTW	Appleton Papers-Locks Mill	na	50s	50s
Heart of the Valley POTW	none know			
Wrightstown POTW	none know			
DePere POTW	U.S. Paper-Depere	na	na	54-97
Green Bay Metro Sewerage District	unknown - flow based estimate			

Table 4b. PCB Calculation Summary By Source: Pulp and Paper Mills.

Facility	Years Release Type Occurred		
	Production	Broke	Secondary Fiber
Kimberly Clark Corporation-Neenah and Badger Globe	na	na	54-97
P.H. Glatfelter Company	na	54-71	54-97
American Tissue Mills	na	na	54-97
Mead Corporation, Gilbert Paper Division	na	na	na
U.S. Paper Mills Corporation, Menasha Division	na	na	54-97
American Can Canal Plant, Menasha	na	na	na
George Whiting Paper Corporation	na	na	na
Wisconsin Tissue Mills	na	54-71	54-97
Riverside Paper Corporation, Kerwin Paper Division	na	71	54-97
Consolidated Paper, Appleton Mill	na	na	na
Consolidated Paper, InterLake Paper Inc.	na	na	54-97?
Appleton Paper, Incorporated - Appleton Coated Papers	54-71	na	na
Appleton Papers, Incorporated - Combined Locks	69-71	54-66	54-97?
International Paper Corporation, Thilmany Division	na	na	na
Charmin, Little Rapids Mill	na	na	na
International Paper Corporation, Nicolet Paper Division	na	na	na
U.S. Paper Mills Corporation, DePere Division	na	yes	54-97
Fort James Corporation, Green Bay East Mill	na	54-71	54-97
Procter & Gamble Paper Products Company	na	na	54-97
Green Bay Packaging Incorporated	na	yes	54-97
Fort James Corporation, Green Bay East Mill	na	na	54-97

8.0 Uncertainty Analysis and Projection of Future PCB Discharges

Each parameter in the PCB discharge calculations exhibits a range of possible values. The range of values for each parameter contributes to the uncertainty of the PCB discharge estimates presented. In many cases, the range of values for a parameter is small and does not affect the PCB release estimates for any individual discharger by more than a few percent. In other cases, the range of values a parameter is larger and may affect the discharge estimate for an individual facility but does not affect the relative importance of the discharge (i.e. the PCB release estimate for an individual discharger may change considerably but still remains negligible in comparison to the sum of releases from all dischargers). However, in a very few cases, the range of possible values for a parameter, even if small, may greatly affect both the discharge estimate for individual facilities as well as the cumulative PCB release from all sources.

Values for many critical parameters, such as production, the PCB content of NCR paper and quantity of NCR Paper broke generated during production, were well defined in technical reports or through information provided to USFWS by each discharger. These well-defined parameters are not considered uncertain. The remaining parameters in the discharge estimates have a wider range of values, and to some extent (different for each parameter) affect estimated PCB releases. The parameters that have the widest range of values or the greatest influence on PCB release estimates are:

1. the PCB loss rate during NCR Paper production;
2. the PCB content of NCR Paper broke;
3. PCB partitioning between products (and waste solids) and wastewater;
4. wastewater treament system efficiencies for Appleton Coated Paper Mill (Appleton POTW), P.H. Glatfelter Company, and Fort James - Green Bay West Mill;
5. fiber furnish factor for PCBs in wastepaper/secondary fiber; and
6. Riverside Paper effluent split to the Neenah-Menash POTW

The influence these six parameters have on PCB release estimates is presented in the disussion below. Following discussion of these parameters, this section concludes with a brief discussion of the magnitude of PCB and TSS discharges to the Lower Fox River that may continue into the future.

PCB loss rate during NCR Paper production. The PCB loss rate during NCR Paper production impacts the discharge estimates for the two mills that produced NCR Paper: the Appleton Coated Papers and Appleton Locks mills. The PCB loss rate is believed to have ranged from 1% to 5%. A production loss rate of 3% was selected as the most representative value for this parameter. Using a 3% loss rate, PCB releases attributable to NCR Paper production amount to 122,450 kg and are a very important component (39%) of cumulative PCB releases to the Lower Fox River. Even if a 1% loss rate is assumed, PCB releases from NCR Paper production would amount to 40,000 kg and would still be a very important component (17%) of the cumulative PCB release to the river. At a 5% loss rate, PCB releases from production would amount to 208,300 kg and would be the largest pathway (52%) of PCB release to the river.

PCB content of NCR Paper broke. The PCB content of NCR Paper broke impacts the discharge estimates for the three large deinking mills in the Fox Valley: Fort James - Green Bay West, P.H. Glatfelter Company, and Wisconsin Tissue. To a lesser extent (because discharge estimates are far smaller), this parameter also effects the discharge estimates for two the smaller deinking mills and three nondeinking mills: Riverside Paper, Appleton Paper Locks Mill, U.S. Paper - Menasha, U.S. Paper - DePere, and Green Bay Packaging. The PCB content of NCR Paper broke is believed to have been less than the 3.4% PCB content of NCR Paper because only 62.5% of the surface area of the broke was coated with the PCB-containing emulsion. The range of broke surface area coating values is not precisely known but was assumed to be in the range of 50% to 75%. In the PCB discharge estimates, NCR Paper broke represented approximately 58% and converter trim 42% of the total amount of material. Using a broke coating fraction of 62.5%, PCB releases attributable to broke/trim deinking and recycle amount to 176,450 kg and are a very important component (56%) of cumulative PCB releases to the Lower Fox River. Even if a 50% broke coating fraction is assumed, PCB releases from broke/trim use would amount to 156,550 kg and would still

be a very important component (53%) of the cumulative release. At a 75% broke coating fraction, PCB releases from broke/trim would amount to 196,350 kg and still be very important component (59%) of the cumulative release. Converter trim represents fully coated product with the full 3.4% PCB content of NCR Paper and is unaffected by this parameter.

PCB partitioning between products and wastewater. PCB partitioning factor impacts the discharge estimates (for broke/trim) for the three large deinking mills in the Fox Valley: Fort James - Green Bay West, P.H. Glatfelter Company, and Wisconsin Tissue. To a lesser extent (because discharge estimates are far smaller), this parameter also effects the discharge estimates for two the smaller deinking mills and three nondeinking mills: Riverside Paper, Appleton Paper Locks Mill, U.S. Paper - Menasha, U.S. Paper - DePere, and Green Bay Packaging. The PCB partitioning factor is believed to have ranged from 25% to 75%. A range of 10% to 50% was suggested by one reference (Valley, 1990) but was presented without supporting quantification. A partitioning factor of 25% was selected to represent condition at the three large and two smaller deinking mills. A partitioning factor of 75% was selected to represent condition at the three nondeinking mills. Even if a 75% partitioning value is assumed for deinking facilities, PCB releases from broke/trim would amount to 42,900 kg and would still be a very important component (23%) of the cumulative PCB release to the river. With a 10% partitioning factor for all deinking facilities and 50% paritioning for the nondeink facilities, PCB releases from broke/trim use would amount to 122,050 kg and would still be slightly less than estimated releases due to production. This parameter does not affect discharge estimates from other facilities since the load estimation technique used for wastepaper/secondary fiber use do not depend on this parameter.

Wastewater treatment system efficiencies: The efficiency of wastewater treament systems for the largest individual dischargers influences the total PCB release from these facilities. The largest dischargers are the Appleton Coated Paper Mill, P.H. Glatfelter Company, and Fort James - Green Bay West. Wastewater treatment plant efficiencies have a less important impact on smaller dischargers such as Wisconsin Tissue, Appleton Locks Mill, Riverside Paper, U.S. Paper-Menasha, U.S. Paper-DePere, and Green Bay Packaging because discharges from these facilities are much smaller than the releases from the larger dischargers.

The Appleton Coated Paper Mill is estimated to be the largest single discharger to the river at 119,900 kg and represents 38% of the cumulative release. The Appleton POTW provided treatment to effluents leaving the Appleton Coated Paper Mill. Primary system treatment efficiencies at the POTW were routinely around 57%. When the POTW was upgraded in 1964 a secondary treatment system was added. Secondary system treatment efficiencies were, in theory, approximately 90% and could increase overall POTW treatment efficiencies to as high as 85% to 95% for wastes that received full treatment. Unfortunately, the 1964 secondary treatment plant was not capable of treating the full load the POTW received. Collection system bypasses and in-plant control diversions limited overall treatment plant efficiency. Of particular note are the years 1967 through 1971. These were years of peak PCB loss from the Appleton Coated Paper Mill and the years of the largest recorded bypassing/control diversion at the Appleton POTW. The secondary treatment system was regularly bypassed when the BOD_5 load applied to the aeration tanks exceeded approximately 16,000 lb/day. Excessive BOD_5 loadings during this period were attributable to the high strength wastes regularly discharged from facilities such as Stokely Foods and Foremost Dairy. In-plant control diversions were frequent during the July to October canning season. Data for the Appleton POTW show that secondary system diversions due to excessive organics loadings occurred even at flows as small as 8 MGD, only one half the design hydraulic capacity of the plant. These data also document the lowest recorded overall treatment plant efficiencies (as low as 63% overall). To address these conditions, operations at the Appleton POTW were modified in 1972 and overall treatment plant efficiencies rose to 90%. However, by the time this occurred, PCB releases from the Appleton Coated Paper Mill had ceased. If treatment efficiencies between 1954 and 1972 were greater than recorded, discharges from the Appleton Coated Paper Mill would decrease significantly but would still remain a significant component (at least 30%) of the cumulative PCB release. However, it is unlikely that treatment efficiencies at the Appleton POTW were much greater than estimated; if they were, there would have been no need for the 1972 Enforcement Conference orders directing the City of Appleton to address wastewater treatment system inadequacies.

The P.H. Glatfelter Company is estimated to be the second largest discharger to the river at 85,000 kg and represents 27% of the cumulative release. This discharge estimate includes releases from Arrowhead Landfill. Treatment system efficiencies at the P.H. Glatfelter Company facility were estimated to average approximately 75% and narrowly range from 73% to 76% between 1954 and 1972. If treatment efficiencies were as much as 80%, the estimated PCB release from this facility would decrease to 71,500 kg. Even if treatment efficiencies approach 90%, the total PCB release from this facility would still amount to 45,000 kg. Under any set of assumptions, discharges from this facility would always remain a significant component of the cumulative PCB release. However, at 90% treatment efficiency P.H. Glatfelter would become the third largest rather than the second largest discharger.

The Fort James - Green Bay West mill is estimated to be the third largest discharger to the river at 70,600 kg and represents 23% of the cumulative release. Treatment system efficiencies at the Fort James - Green Bay West facility were estimated to be 92% between 1954 and 1972. If treatment efficiencies were as low as 80%, the estimated PCB release from this facility would increase to 155,800 kg. Under any set of assumptions, discharges from this facility would always remain a significant component of the cumulative PCB release. However, at 80% treatment efficiency Fort James - Green Bay West would become the largest rather than the third largest discharger.

It should be noted that similar analyses can be performed for other, smaller dischargers such as Wisconsin Tissue and Riverside Paper. Both of these facilities discharged through POTWs that were subject to bypasses which limited overall wastewater treatment efficiencies. Greater treatment efficiency would further reduce the relative importance of these already small components of the overall release.

Fiber furnish factor. The fiber furnish factor approach assumed that PCBs measured in effluents between 1974 and 1977 occurred when PCBs were still at their peak availability in the fiber stream. This approach provides a lower bound for estimated PCBs releases due to wastepaper/secondary fiber recycling. The approach assumes that the 1974-1977 effluent observations represent starting point for the exponential decay of PCBs in the fiber stream from the peak value of 1.0 which was assigned to the years 1970 through 1977. If PCBs in the fiber stream began to decline in the first one to two years following the end of NCR Paper production using the PCB-containing emulsion, then the 1974-1977 effluent PCB observations would have actually represented conditions with considerably lower PCB concentrations than would have occurred during the peak years of release. If this condition actually occurred and PCBs in the fiber stream began to decline more rapidly than estimated, then PCB releases attributable to wastepaper/secondary fiber recycling would have been proportionately greater than estimated using the present method.

Riverside Paper discharge split between the Lower Fox River and Appleton POTW. Riverside Paper split its discharge between the river and the Appleton POTW. Data that Appleton POTW provided to USFWS indicated that Appleton POTW did not receive effluent from Riverside Paper until 1979. This conflicts with Department records and other information. These other records suggest that Riverside Paper may have at least occasionally sent some effluent to Appleton POTW for treatment prior to 1979. For example, Department effluent monitoring records show PCB samples for effluents discharged to Appleton POTW from Riverside Paper between 1974 and 1977. Despite this conflicting information, the discharge estimates presented for Riverside Paper were based on the assumption that no effluents were split to the Appleton POTW prior to 1979. It is important to recognize that even during the era of maximum collection system bypass and POTW overload (hydraulic/organics loading), effluents treated at the Appleton POTW would have received more effective overall treatment than wastes treated at Riverside Paper. If Riverside Paper routinely discharged a significant portion of its process water to the Appleton POTW prior to 1979, then the PCB discharge from Riverside Paper may be overestimated (because more flow would have been treated at Appleton POTW and less flow discharged directly to the river). It is also important to recognize that the estimated PCB release from Riverside Paper is already an essentially negligible component of the total PCB release to the river. If overestimated, this already negligibly small load would be even smaller.

Future PCB releases. PCB releases to the Lower Fox River are expected to continue into the future as long as PCB levels in wastepaper/secondary fiber sources are greater than zero. In absolute terms, future PCB discharges are reasonably expected to be very small and grow smaller over time. Relative to expected releases from river sediments, future PCB discharges would be negligibly small.

From 1977 to 1997, PCB levels in secondary fiber declined exponentially at a rate of approximately 0.15/year. At this rate of decline it would require an additional 30 to 50 years for fiber furnish PCB levels to reach 1 ppt. To be representative, water quality simulations of future conditions must logically include future PCB releases to the Lower Fox River. It is therefore recommended that future PCB discharges be represented using the procedure outlined for PCB Load Estimation Method 1.5 (see Table 3) continuing the decline in fiber furnish PCB levels at a rate of 0.15/year for at least 50 years past 1997 (i.e. 2047).

Future TSS Releases. TSS releases to the Lower Fox River will continue as long as municipal and industrial dischargers exist. From the early 1970s through the 1980s, TSS discharges from all sources have declined dramatically. While wastewater treatment facilities may never become 100% efficient at removing particles from wastewater, present TSS loads are negligible relative to watershed sources of solids. For the purpose of PCB transport and fate model evaluation, it is sufficient to represent future TSS discharges to the Lower Fox River at their 1997 levels. Future changes in wastewater treatment efficiency would not affect the overall solids balance in the PCB transport and fate models because point source TSS loads are so small relative to other sources of solids.

9.0 Summary of PCB Discharges

PCB discharges to the Fox River resulted from the production of NCR Paper, recycle of NCR Paper broke and converter trim, and the recycle of wastepaper/secondary fiber that contained some NCR Paper. Two primary factors control the calculated amount of discharge. These factors are the PCB loss rate during from coating operations during NCR Paper production and the partitioning of PCBs to product in deinking mills. The production loss rate impacts discharges from the two mills that produced NCR Paper. Production loss rates estimates range from 1% to 5%. The value for PCB partitioning to product impacts discharges from deinking mills. PCB partitioning factor estimates range from 25% to 75%. A wider range of partitioning factor values may also be possible.

Estimated cumulative PCBs releases are 399,450 kg if the PCB loss rate during production was 5% and 25% of PCBs in broke/trim partition to product. Estimated cumulative releases are 126,500 kg if the loss rate was 1% and 75% of PCBs in broke/trim partition to product. A 3% loss rate best represents PCB losses during production based on consideration of the NCR Paper coating operations. A 25% partitioning factor best represents PCB partitioning to products in deinking mills. If 75% of the PCBs in broke/trim partitioned to product, paper products made at deinking mills would have had PCB concentrations up to 690,000 ppb. Unless data that indicate such product PCB concentrations actually occurred become available, a 25% partitioning factor best represents the PCB partitioning factor for deinking mills. For a 3% production loss rate and 25% partitioning factor, cumulative PCB releases to the Lower Fox River are 313,600 kg. Of this amount, 122,450 kg (39%) originated from production, 176,450 kg (56%) from broke/trim use, and 14,700 kg (5%) from wastepaper/secondary fiber use.

The relative importance of the three PCB release pathways is presented in Figures 8. PCB discharges from NCR Paper production ranged from 17% to 71% of the cumulative release to the Lower Fox River. PCB discharges from NCR Paper broke/converter trim use ranged from 24% to 76%. PCB discharges from wastepaper/secondary fiber use ranged from 4% to 12%. The ranges vary widely as a result of different assumptions regarding PCB losses during production and the PCB partition factor used for deinking mills. The peak years of PCB discharge are 1968 to 1970. Over 98% of the PCB release occurred by the end of 1972. Total annual estimated PCB loads are presented in Figure 9.

The five largest dischargers are: Appleton Coated Paper Mill, P.H. Glatfelter Company and the associated Arrowhead Landfill, Fort James - Green Bay West, Wisconsin Tissue, and Appleton Locks Mill. The three largest dischargers account for 90% of the PCBs release to the river. The four largest dischargers account for nearly 98% of the total release. The five largest dischargers account for more than 99% of the total release. Although their relative order may change in response to different assumptions regarding PCB losses during production and partitioning, under any set of assumptions the five largest dischargers identified always remain the five largest dischargers. Several other facilities may have released small quantities of PCBs from either limited broke/trim use or wastepaper/secondary fiber recycling. Relative to the five largest dischargers, the combined estimated release for all other dischargers accounts for less than 1% of the cumulative PCB release and is insignificant in comparison. Annual estimated PCB releases from the largest dischargers for the period 1954 to 1997 are presented in Appendix D. The relative contribution of the discharges to the total PCB release is presented in Figure 10. Cumulative PCB loads from the dischargers are presented in Figure 11.

Given that a few discharges are the predominant components (90% to 99%) of the cumulative PCB release, PCB transport and fate model hindcast simulation efforts can be significantly simplified by representing only the few large discharges as the total PCB discharge to the river. Any simplified simulation must logically include the three largest dischargers: Appleton Coated Paper, P.H. Glatfelter, and Fort James - Green Bay West. Although less important, it may be desirable to also include the Wisconsin Tissue and Appleton Locks Mill discharges in PCB transport and fate model hindcast simulations. These three major, one minor, and one very small dischargers represent more than 99% of the cumulative PCB release.

Finally, it should be noted that some effluent measurements had detectable PCB concentrations quantified as Aroclors 1254 and 1248 that were reported for various facilities including POTWs, machine shops, and

paper mills. PCBs were used in many commercial and industrial applications. Higher-chlorinated PCB mixtures such as Aroclor 1254 and Aroclor 1248 were used as electrolytes, cutting oils, hydraulic oils, and as other products. Releases of these PCB-containing materials undoubtedly account for the occasional observation of Aroclor 1254 and 1248 in effluents. These data are shown in Appendix C. In contrast, the PCB-containing emulsion used to manufacture NCR Paper contained only Aroclor 1242. It is highly unlikely that PCBs quantified as Aroclor 1254 or 1248 originated from NCR Paper. Given that PCBs in Lower Fox River sediments are quantified almost exclusively as Aroclor 1242, possible PCB releases attributable to sources other than NCR Paper are negligible in comparison. Therefore, no attempt was made to quantify discharges of Aroclors 1254 or 1248.

Figure 1. TOTAL TSS LOAD - MILLS

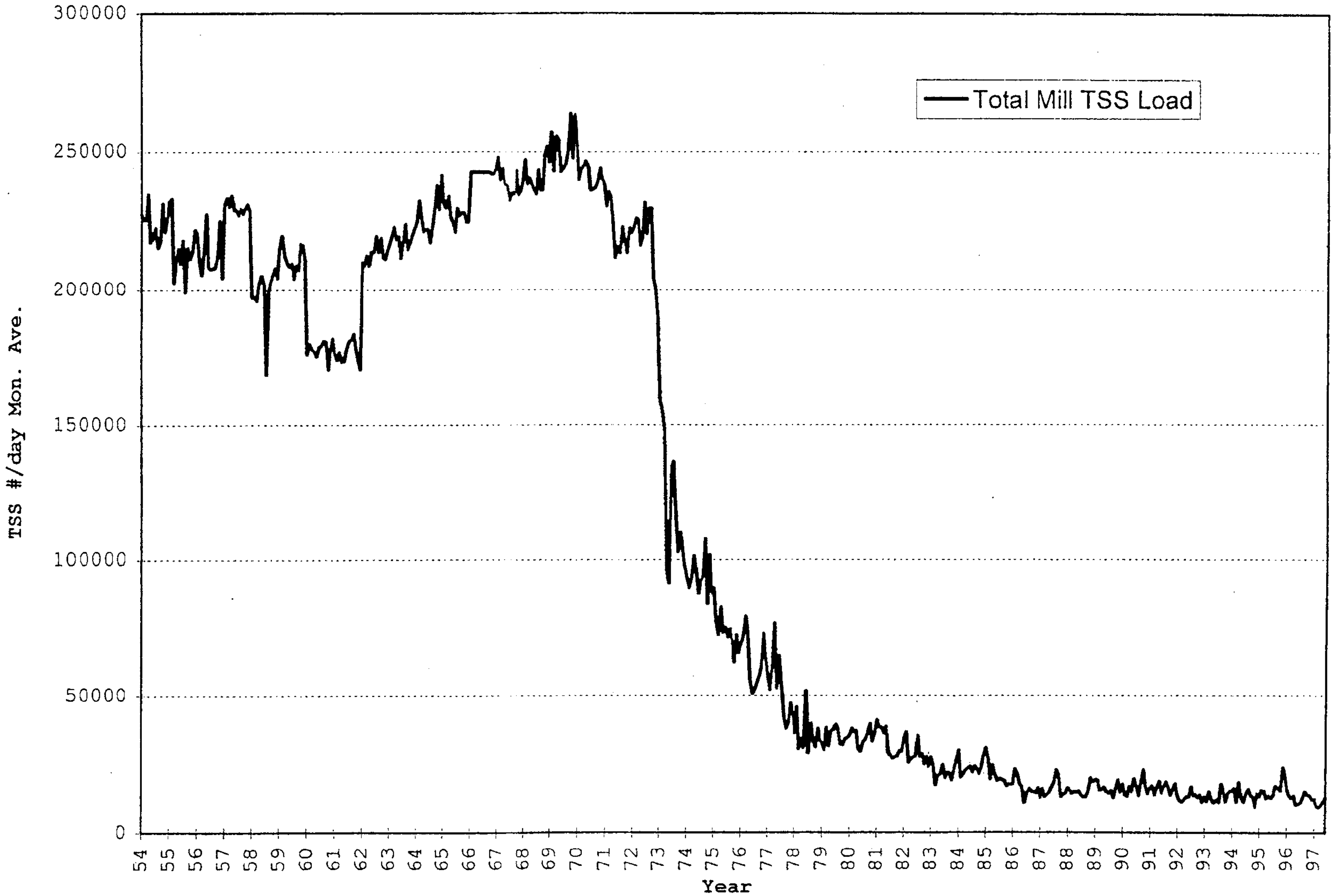


Figure 2. TOTAL TSS LOADS - POTWs

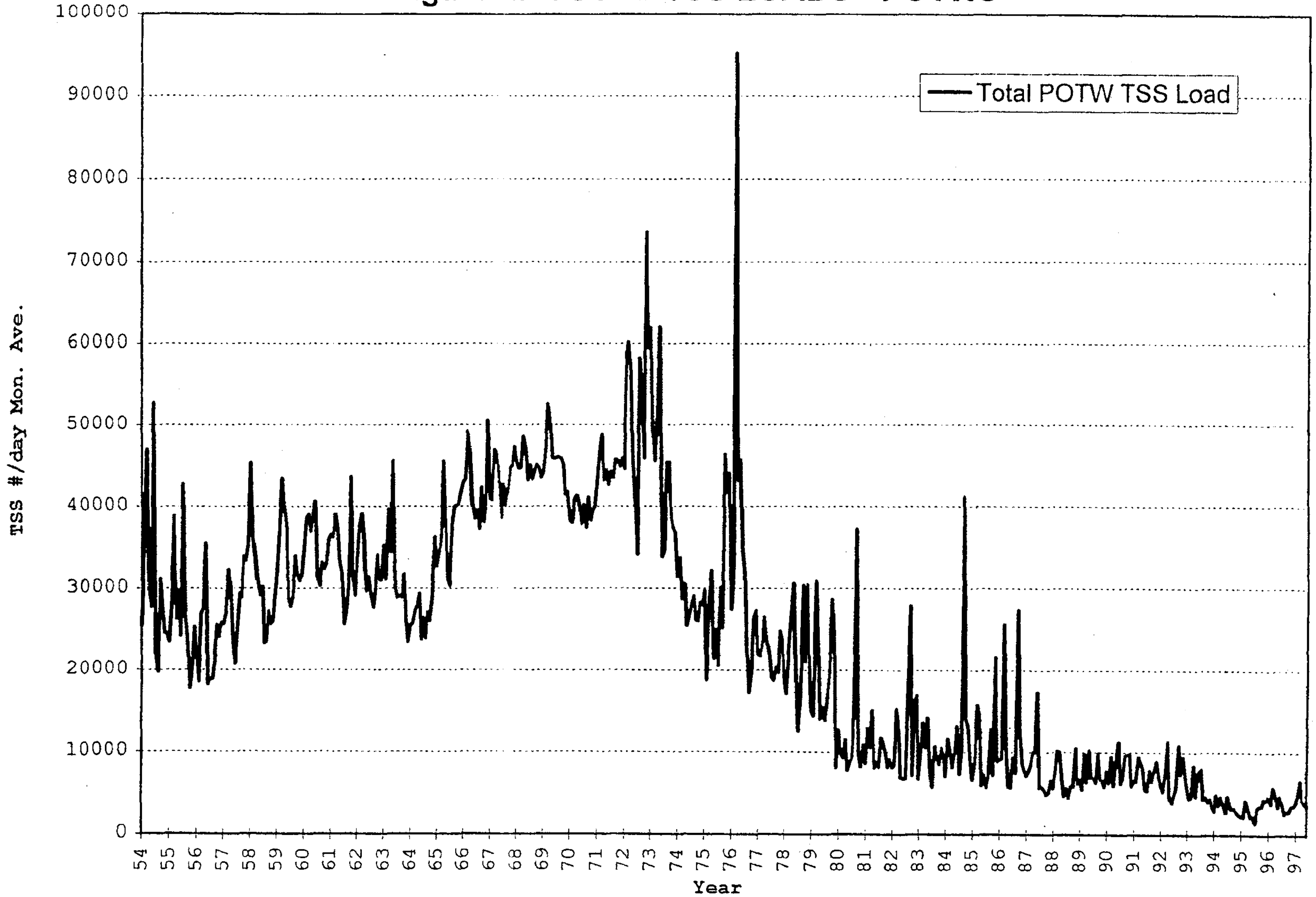


Figure 3. TOTAL TSS LOAD - POTWs AND MILLS

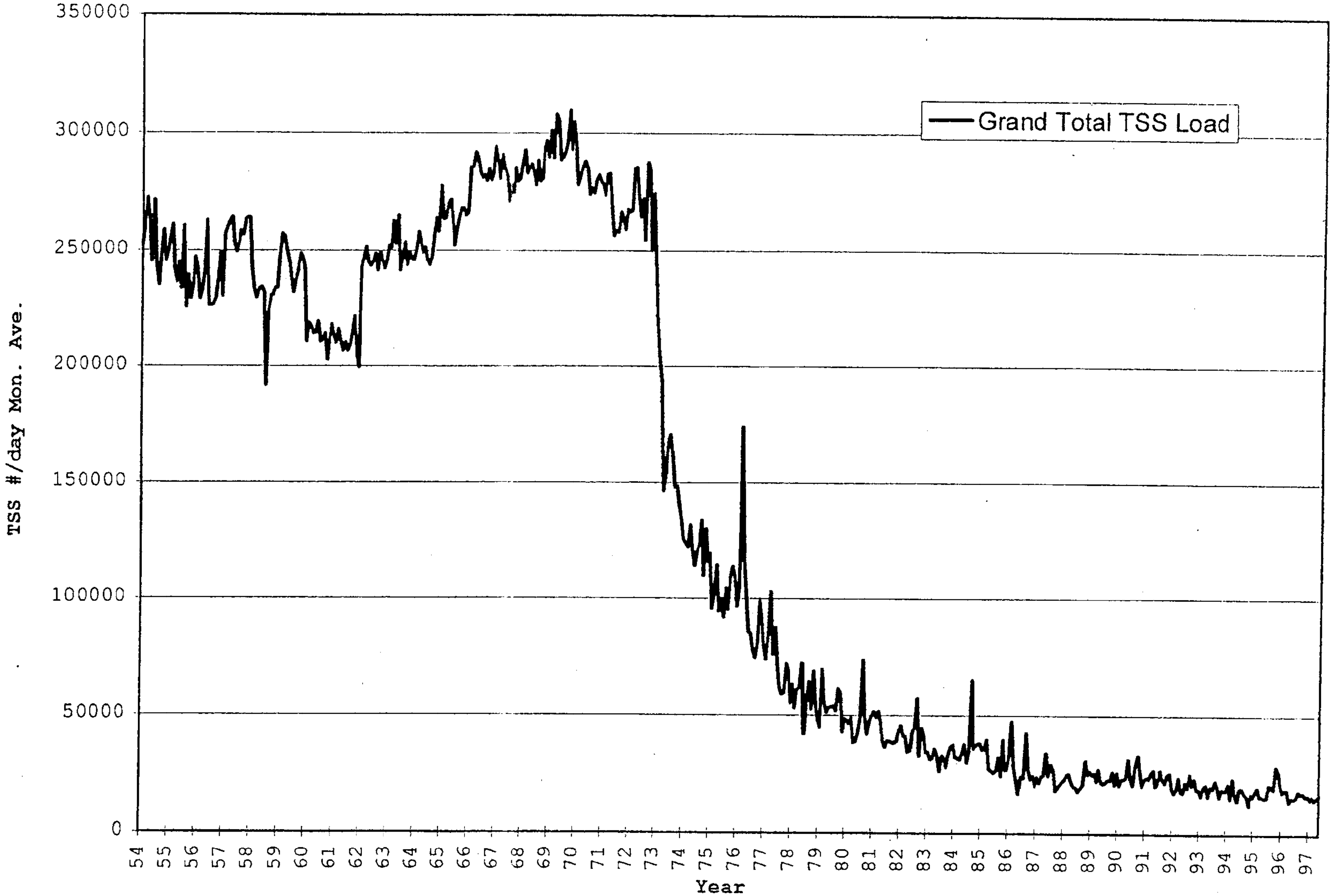


Figure 4. Wastepaper/Secondary Fiber PCB Fiber Furnish Factor

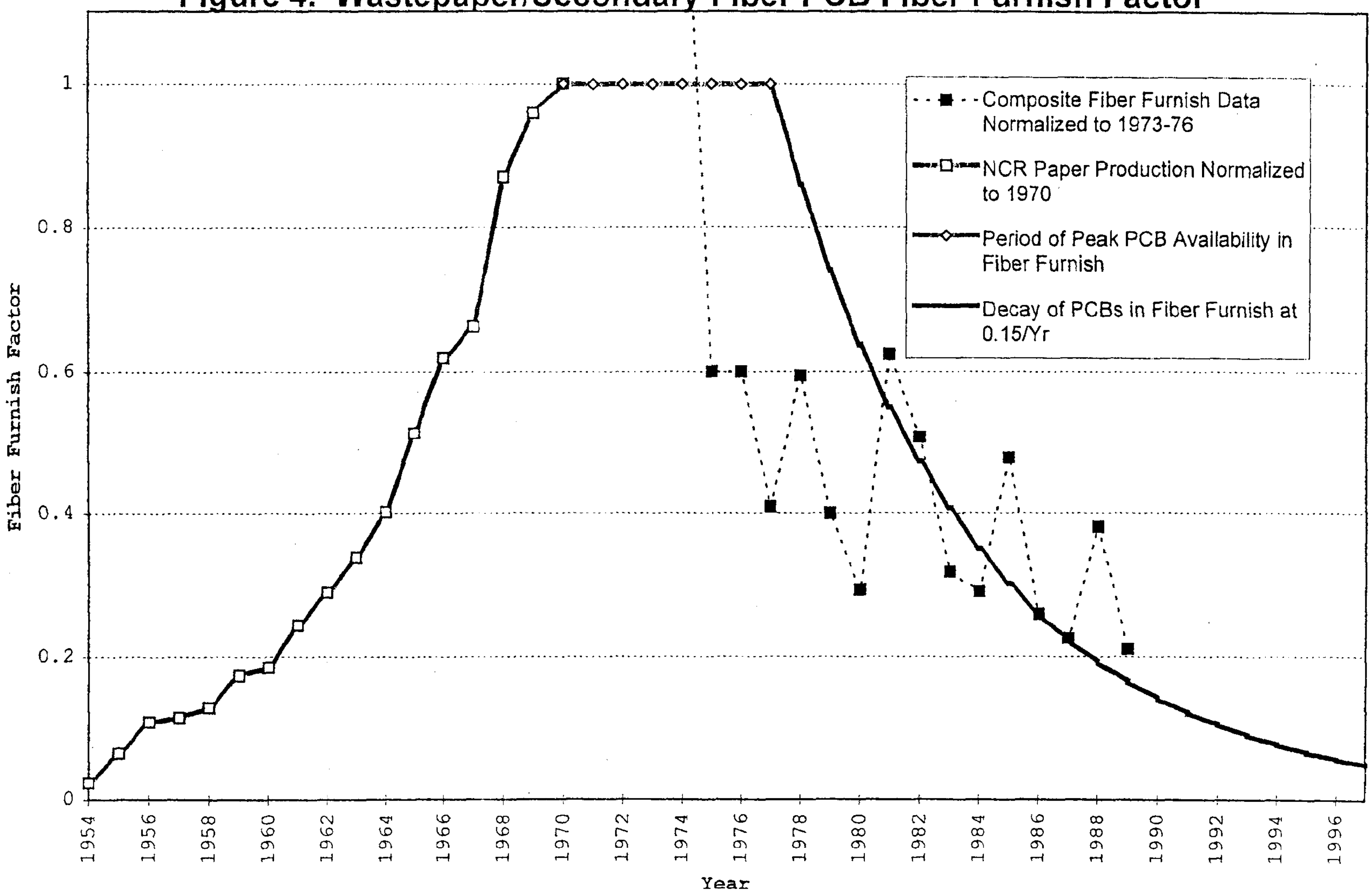


Figure 5. Reams of NCR Paper Produced In US vs. Production at Appleton Coated Papers

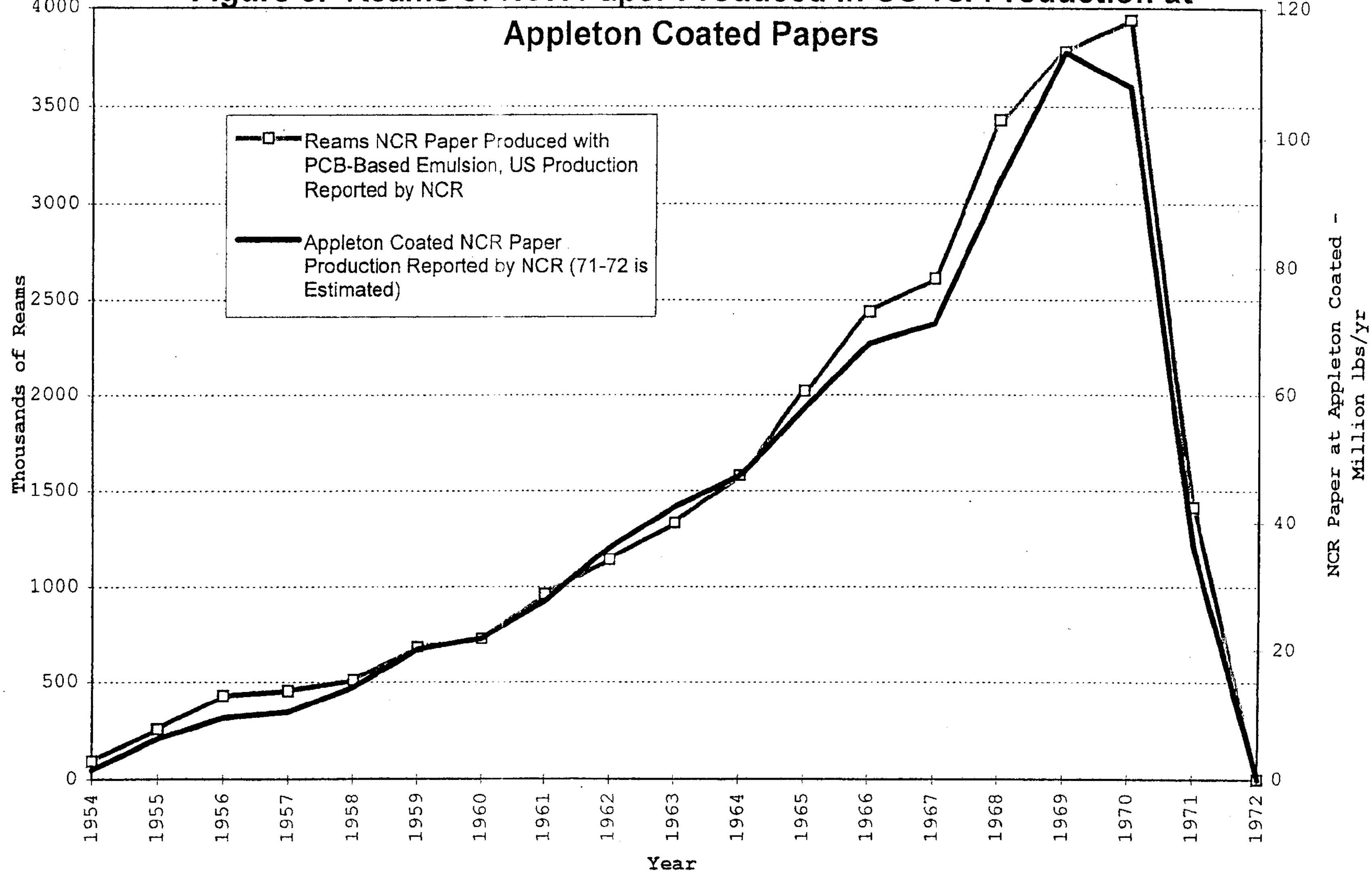


Figure 6. Total Emulsion Production vs. Use In the Fox Valley

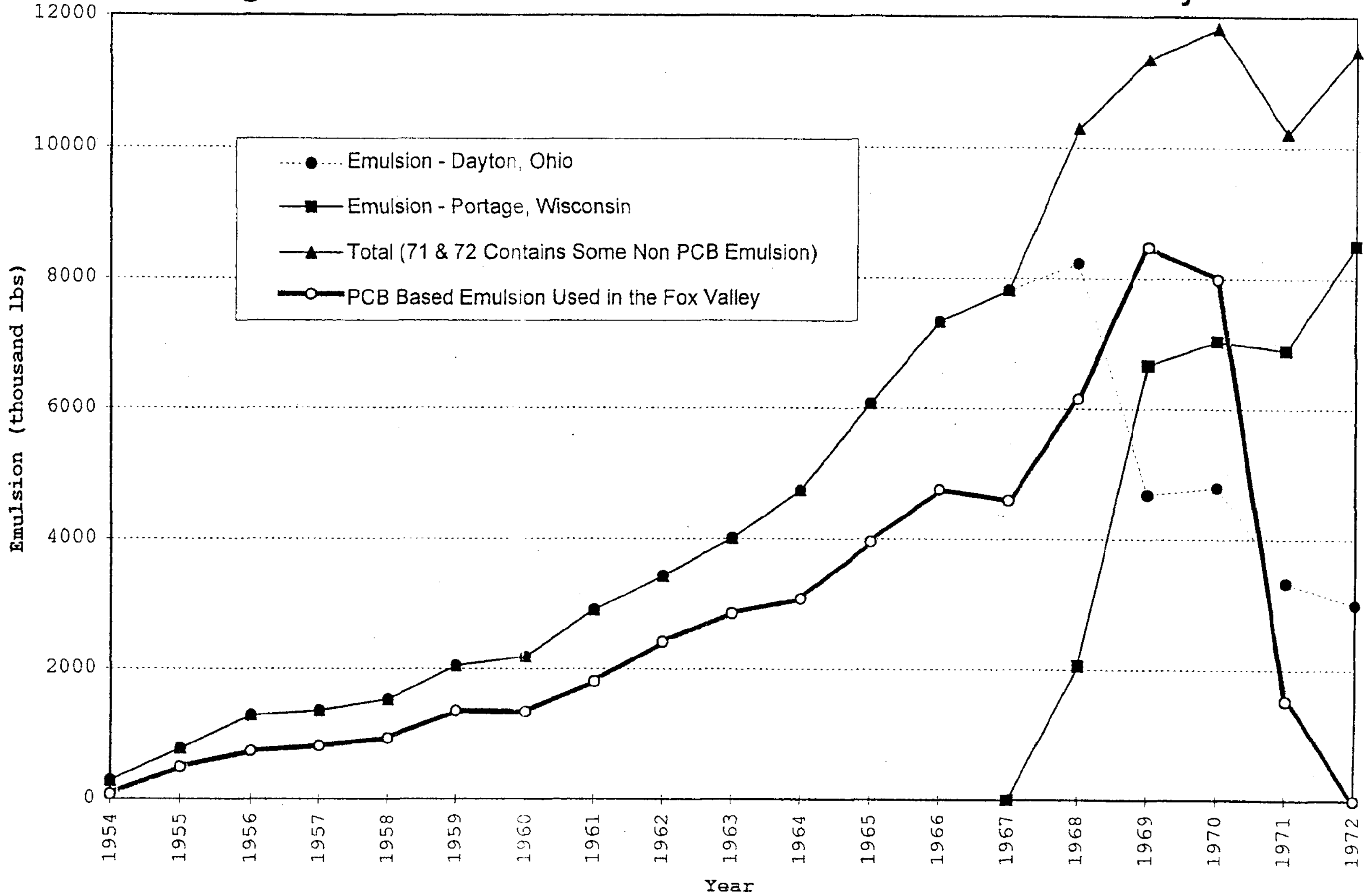


Figure 7. TSS Discharge vs. Emulsion Use

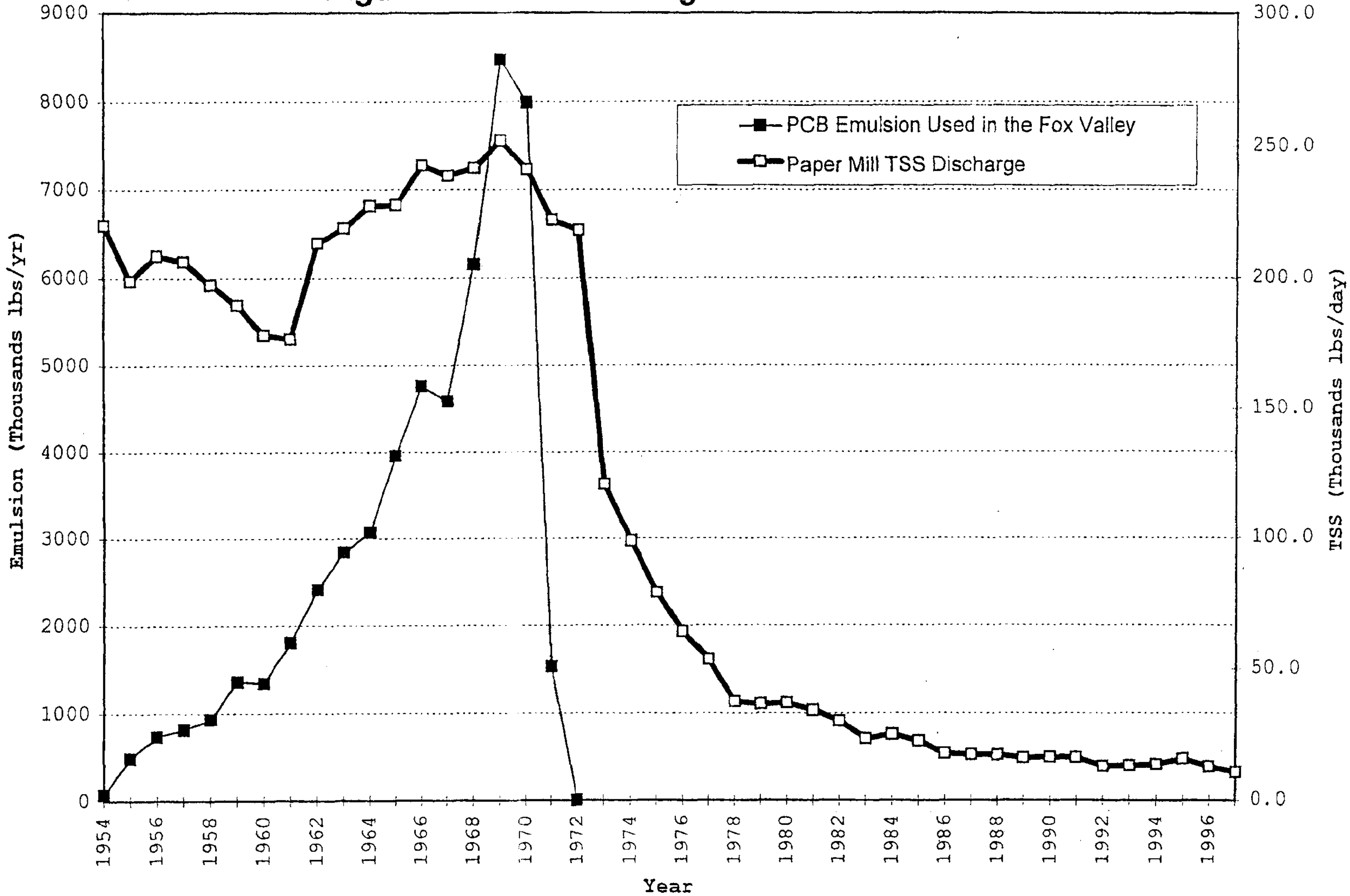


Figure 8: PCB Load by Release Pathway

3% Production Loss and 25% PCB to Product

Cumulative PCB Release = 313,600 kg

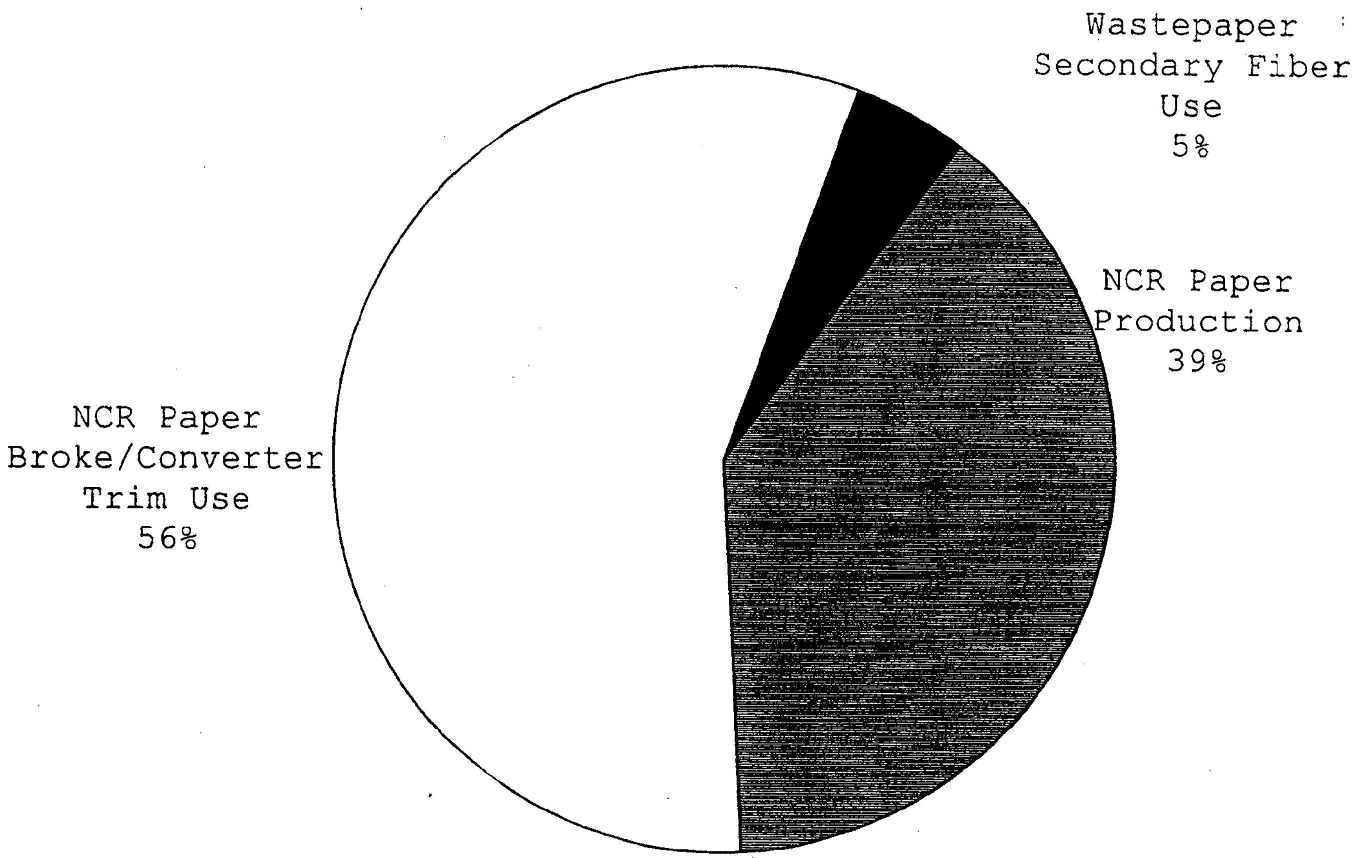


Figure 9: Total Annual Estimated PCB Loads

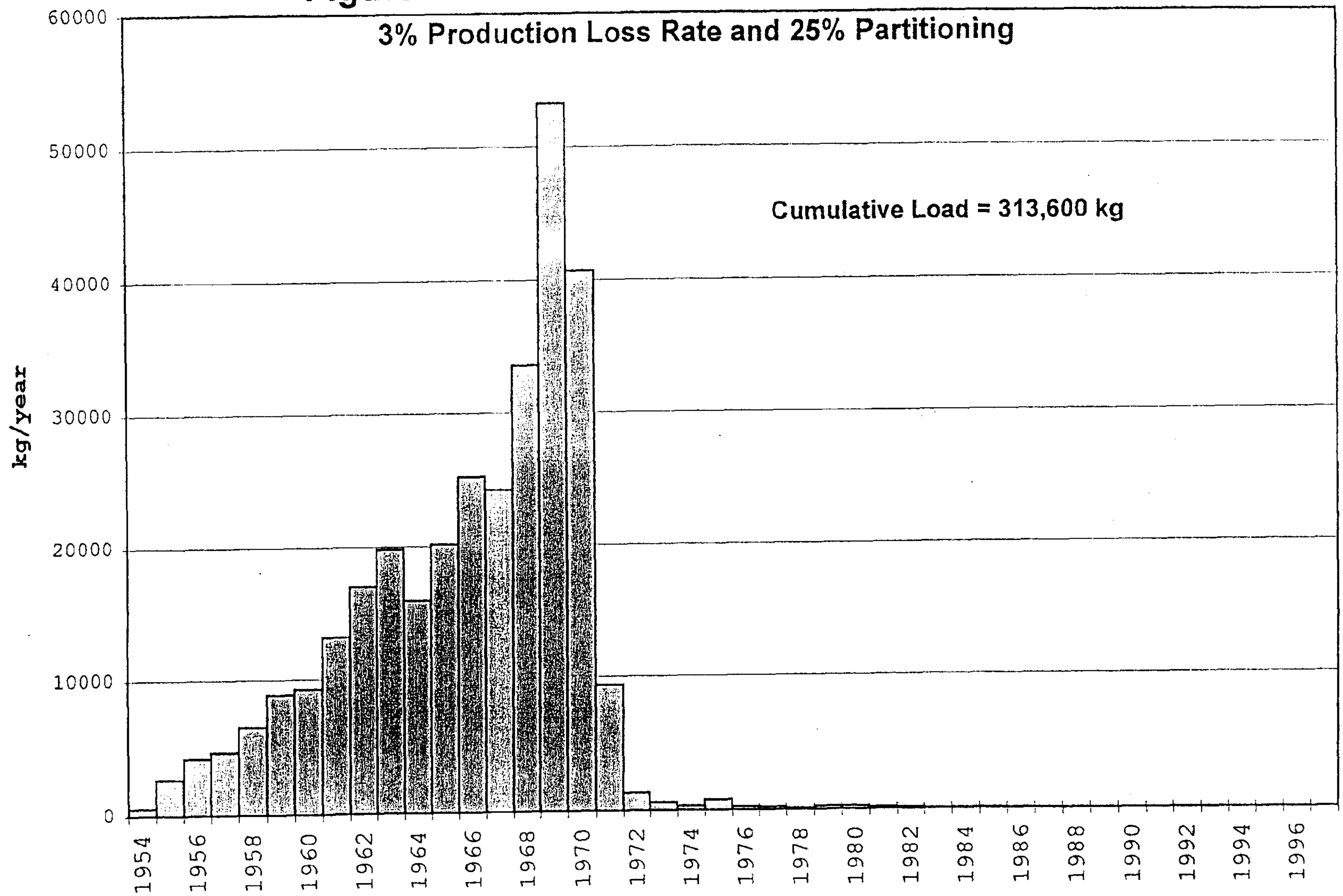


Figure 10: Relative Contributions of PCB Dischargers
3% Production Loss and 25% Partitioning

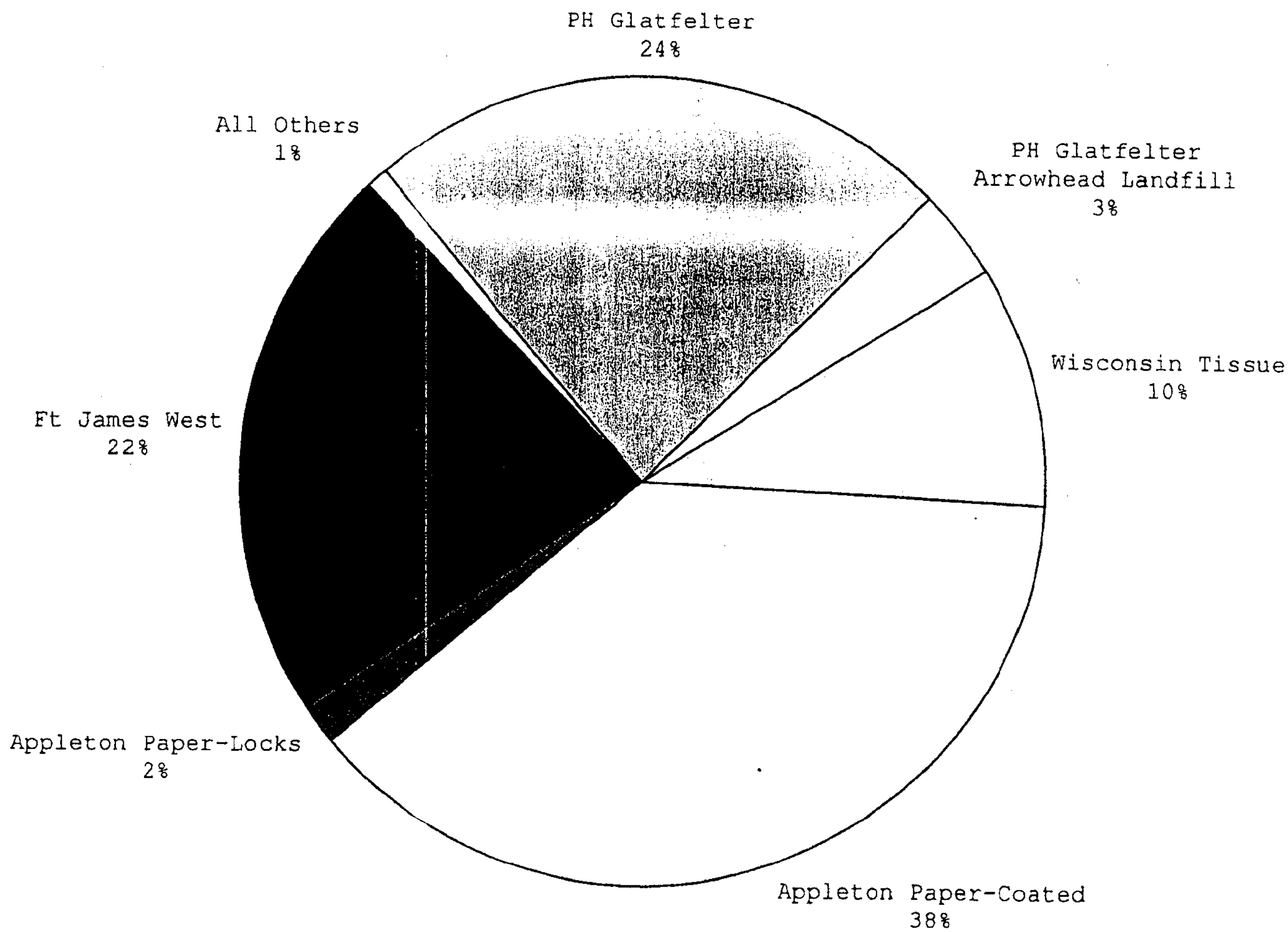
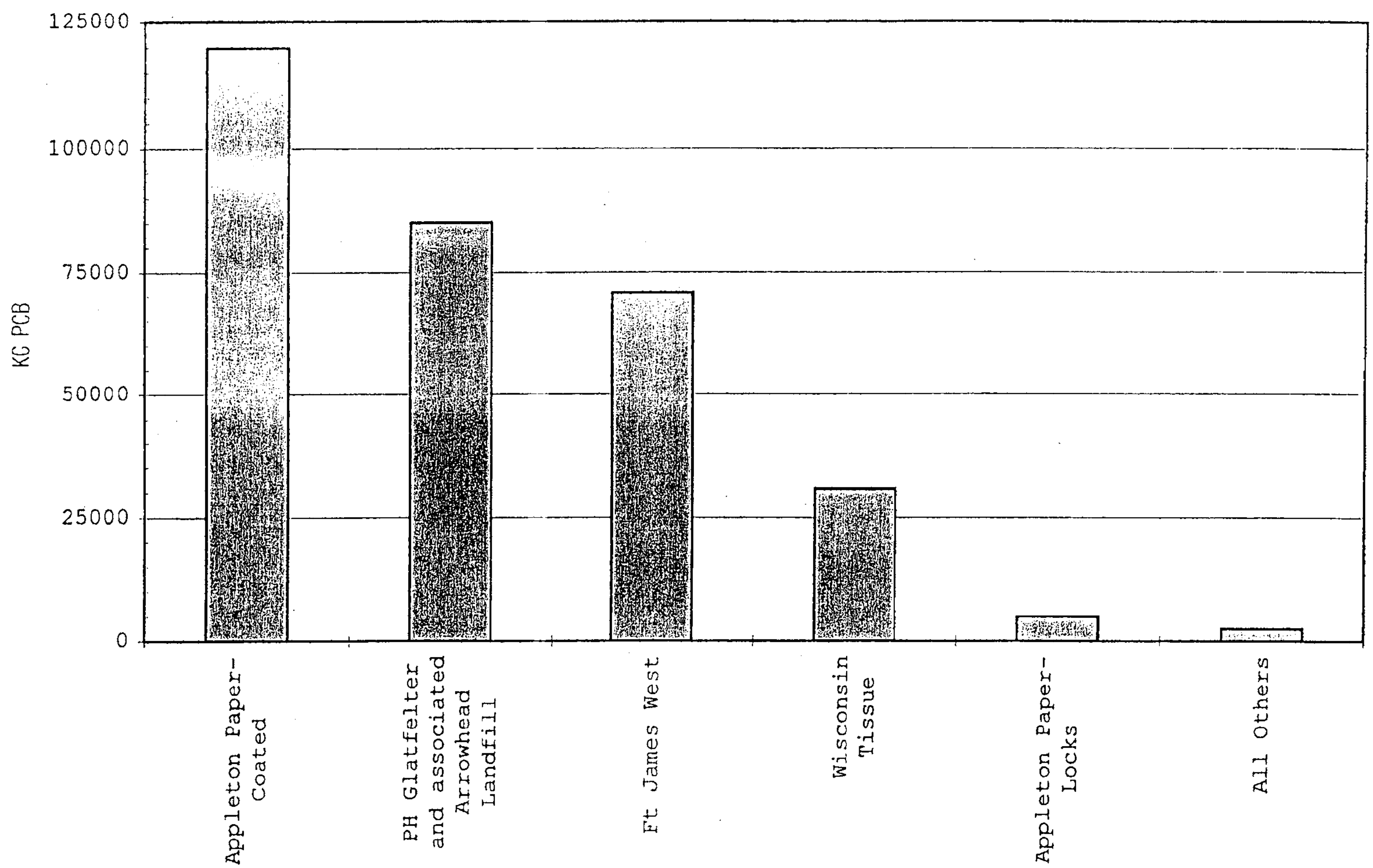


Figure 11: Cumulative PCB Loads by Discharger

3% Production Loss Rate and 25% Partitioning



Appendix A

Sources of TSS and Effluent Flow Data and Point Source TSS and Flow Graphs

Many sources of data were reviewed for records of flow volume and solids discharge to gather the needed information for each point source. Sources that were used in this report are listed below, followed by an individual listing for each point source itemizing which sources were used by time period. Data was desired for daily mean discharge averaged over a month. If a single value was available for a given year, that value was used for the entire year. Averages or interpolations were used to fill gaps in the data record.

Records available in Department files were used in this exercise. No attempt was made to obtain data from each point source. It should be noted that SEMORE reports were submitted by all point sources during the period of 1974 through 1981. Department copies of these documents have been destroyed several years ago and electronic summaries were not routinely kept until 1982. Consequently, much of the discharge data between 1974 and 1981 was not obtainable. Fortunately, special summaries of point source discharges on the Fox River had been tabulated for presentation to the Natural Resources Board. These summaries primarily recorded BOD and TSS for industrial point sources, but not flow volume. After all DNR data was compiled, remaining gaps were compared to information available to the USFWS from responses to specific interrogatories for some of the point sources. Any data that could fill these gaps was used and is referenced in the compilation below as coming from the FWS. Graphs included in this appendix display the TSS load and flow for each discharger for the entire period (flow gaps were not filled in for those dischargers that did not an estimated PCB discharge). The graphs are arranged with paper mills first in downstream order, followed by the POTWs in downstream order.

Settling characteristics were also estimates for each point source to account for the changes in solids settling rates as treatment was improved. The method used to separate the solids is explained in Section 4.0. The results are presented below as the percent of total solids load that is low rate settling solids and the appropriate time period.

Table A-1. Flow and TSS Data Sources: Municipal Treatment Plants.

Neenah-Menasha POTW	
Flow	1/54-7/65, 10/69, 10/70, 6/71, 1/72-12/78=FWS, 1/79-12/79=DNRHT, 1/80-12/80=FWS, 1/82-6/97=DMR
TSS	1/54-7/65, 10/69, 10/70, 6/71, 1/72-12/74=FWS, 1/75-12/76=SEMORE, 1/77-12/78=FWS, 1/79-12/79=DNRHT, 1/80-12/80=FWS, 1/82-6/97=DMR
BP	1/54-12/64=FWS, 1/80-6/97=FWS
LR%	1/54-12/64=36%, 1/65-12/73=50%, 1/74-4/86=90%, 5/86-6/97=100%
Menasha East POTW	
Flow	6/78-9/80=DNRHT
TSS	6/78-9/80=DNRHT
LR%	1/54-9/80=80%
Menash West and Grand Chute/Menasha West POTWs	
Flow	66-67=Poll66, 6/78-8/80=DNRHT
TSS	6/78-8/80=DNRHT
LR%	1/54-12/82=80%, 1/83-6/97=100%

Flow = Flow Data, TSS = Total Suspended Solids Data, LR% = Low Rate Solids Settling Percent

Table A-1 (continued). Flow and TSS Data Sources: Municipal Treatment Plants.

Appleton POTW	
Flow	66-67=Poll66, 1/78-12/78=DNRHT, 1/79-12/81=FWS, 1/82-6/97=DMR
TSS	57=POLL57, 72-73=PERM73, 6/72-9/72=DNR72, 74=PERM74, 1/75-12/76=SEMORE, 1/78-12/78=DNRHT, 1/79-12/81=FWS, 1/82-6/97=DMR
BP	54-57=HEAR57, 58-72=ENF72
LR%	1/54-12/62=35%, 1/63-11/79=50%, 12/79-6/97=100%
Kimberly and Little Chute POTWs	
Flow	57=POLL57, 66-67=POLL66
TSS	57=POLL57, 66-67=POLL66
LR%	1/54-12/75=50%
Heart of the Valley (Kaukauna) POTW	
Flow	66-67=POLL66, 71=ENF72, 1/78-10/80=DNRHT, 1/82-6/97=DMR
TSS	57=POLL57, 72-73=PERM73, 6/72-9/72=DNR72, 1/78-10/80=DNRHT, 1/82-6/97=DMR
LR%	1/54-12/75=50%, 1/76-6/97=100%
Wrightstown POTW	
Flow	66-67=POLL66, 1/78-9/80=DNRHT, 1/82-6/97=DMR
TSS	57=POLL57, 1/78-9/80=DNRHT, 1/82-6/97=DMR
LR%	1/54-12/80=35%, 1/81-6/97=100%
DePere POTW	
Flow	66-67=POLL66, 71=ENF72, 1/74-12/81=FWS, 1/82-6/97=DMR
TSS	57=POLL57, 6/72-9/72=DNR72, 8/73-12/81=FWS, 1/82-6/97=DMR
BP	54-72=ENF72
LR%	1/54-12/65=35%, 1/66-12/74=20%, 1/75-6/78=50%, 7/78-6/97=100%
Green Bay Metro Sewerage District	
Flow	1/54-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/81=FWS, 1/82-6/97=DMR
BP	54-57=HEAR57, 1/58-12/68=ENF72
LR%	1/54-12/72=20%, 1/73-12/77=35%, 1/78-12/92=70%, 1/93-6/97=100%

Flow = Flow Data, TSS = Total Suspended Solids Data, LR% = Low Rate Solids Settling Percent

Table A-2. Flow and TSS Data Sources: Pulp and Paper Mills.

Kimberly Clark Corporation-Neenah and Badger Globe	
Flow	1/54-12/67=COOP, 1/75-12/76=No Discharge (SEMORE), 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-1/75=15%, 2/75-12/76=To POTW, 1/77-6/97=100%
P.H. Glatfelter Company	
Flow	1/54-12/59=FWS, 1/60-12/67=COOP, 1/68-12/68=FWS, 4/74-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/59=FWS, 1/60-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-12/70=28%, 1/71-8/78=79%, 9/78-6/97=100%
American Tissue Mills	
Flow	1/54-12/67=COOP, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-12/70=5%, 1/71-4/75=53%, 5/75-6/97=100%
Mead Corporation, Gilbert Paper Division	
Flow	1/54-12/67=COOP,
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-1/74=SEMORE, 2/74-6/97=To POTW
LR%	1/54-3/73=11%, 4/73-1/74=56%, 2/74-6/97=To POTW

Flow = Flow Data, TSS = Total Suspended Solids Data, LR% = Low Rate Solids Settling Percent

Table A-2 (continued). Flow and TSS Data Sources: Pulp and Paper Mills.

U.S. Paper Mills Corporation, Menasha Division (John Strange)	
Flow	1/54-12/67=COOP,
TSS	1/54-12/67=COOP, 6/72-9-72=DNR72, 4/73-5/76=SEMORE, 6/76-Pres.=To POTW
LR%	1/54-5/76=15%, 6/76-6/97=To POTW
American Can Canal Plant, Menasha	
Flow	1/54-12/63=COOP, 65=COOP, 1/66=Closed
TSS	1/54-12/63=COOP, 65=COOP, 1/66=Closed
LR%	1/54-12/63=10%, 1/64-6/97=No Discharge
George Whiting Paper Corporation	
Flow	1/54-12/67=COOP,
TSS	1/54-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 5/73-10/81=SEMORE, 11/81-6/97=To POTW
LR%	1/54-12/74=4%, 1/75-10/81=28%, 11/81-6/97=To POTW
Wisconsin Tissue Mills	
Flow	1/54-12/60=COOP, 1/61-4/73=To POTW, 5/73-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/60=COOP, 1/61-4/73=To POTW, 5/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-11/75=10%, 12/75-6/97=100%
Riverside Paper Corporation, Kerwin Paper Division	
Flow	1/54-12/67=COOP, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 70=ENF72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-3/73=10%, 4/73-6/97=20%
Consolidated Paper, Appleton Mill	
Flow	1/54-12/67=COOP
TSS	1/54-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 4/73-11/82=SEMORE, 12/82=Closed
LR%	1/54-3/75=17%, 4/75-11/82=67%, 12/82-6/97=Closed
Consolidated Paper, Inter Lake Paper Inc.	
Flow	1/54-12/67=COOP, 9/76-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-3/73=11%, 4/73-6/78=56%, 7/78-6/97=100%
Appleton Papers, Incorporated - Appleton Coated Papers	
Flow	10/73-3/96=FWS
TSS	10/73-3/96=FWS
LR%	1/54-6/97=To POTW
Appleton Papers, Incorporated - Combined Locks	
Flow	1/54-12/67=COOP, 4/73-12/82=FWS, 1/83-6/97=DMR
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-12/76=SEMORE, 1/77-12/82=FWS, 1/83-6/97=DMR
LR%	1/54-12/72=7%, 1/73-12/78=42%, 1/79-6/97=100%
International Paper Corporation, Thilmany Division	
Flow	1/54-12/67=COOP, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-8/73=50%, 9/73-3/78=77%, 4/78-6/97=100%
Charmin, Little Rapids Mill	
Flow	1/54-12/55=No discharge, 1/56-10/67=COOP, 11/67 Closed
TSS	1/54-12/55=No discharge, 1/56-10/67=COOP, 11/67 Closed
LR%	1/54-10/67=10%, 11/67=Closed
International Paper Corporation, Nicolet Paper Division	
Flow	1/54-12/67=COOP, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-12/70=11%, 1/71-6/97=56%

Flow = Flow Data, TSS = Total Suspended Solids Data, LR% = Low Rate Solids Settling Percent

Table A-2 (continued). Flow and TSS Data Sources: Pulp and Paper Mills.

U.S. Paper Mills Corporation, DePere Division	
Flow	63, 65-67=COOP, 1/72=No discharge
TSS	63, 65-67=COOP, 1/72=No discharge
LR%	1/54-12/71=50%, 1/72-6/97=To POTW
Fort James Corporation, Green Bay West Mill	
Flow	1/54-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/72=FWS, 1/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-3/73=6%, 4/73-5/81=18%, 6/81-6/97=100%
Procter & Gamble Paper Products Company	
Flow	1/54-12/67=COOP, 1/82-6/97=DMR
TSS	1/54-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 4/73-12/81=SEMORE, 1/82-6/97=DMR
LR%	1/54-12/69=43%, 1/70-9/75=71%, 10/75-6/88=90%, 7/88-6/97=100%
Green Bay Packaging Incorporated	
Flow	1/54-12/67=COOP&FWS, 1/68-12/81=FWS, 1/82-6/97=DMR
TSS	1/54-12/67=COOP&FWS, 1/68-12/81=FWS, 1/82-6/97=DMR
LR%	1/54-5/72=4%, 6/72-6/97=100%
Fort James Corporation, Green Bay East Mill	
Flow	1/54-12/67=COOP, 1/74-3/82=FWS, 4/82-6/97=DMR
TSS	1/54-12/67=COOP, 70=ENF72, 6/72-9/72=DNR72, 4/73-12/73=SEMORE, 1/74-2/89=FWS, 3/89-6/97=DMR
LR%	1/54-12/75=17%, 1/76-2/84=67%, 3/84-6/97=100%

Flow = Flow Data, TSS = Total Suspended Solids Data, LR% = Low Rate Solids Settling Percent

The following key lists reports or data summaries used to compile flow and TSS discharges for this report:

COOP	= Cooperative Mill Surveys done annually from 1920s to 1967.
DNRHT	= DNR Hand Tabulated Discharge Summaries from Area Engineers.
HEAR57	= Hearings Before the Committee on Water Pollution and State Board of Health, March 1957.
POLL57	= Drainage Area 11a - Stream Pollution Lower Fox River, Wisconsin State Board of Health, March 21, 1957.
EAST	= Report on Investigation of the East River in the City of Green Bay and Vicinity, 1957-1958, Green Bay, GBMSD and Wisconsin Committee on Water Pollution, November 1958.
POLL66	= Report on an Investigation of the Pollution in the Lower Fox River and Green Bay Made During 1966 and 1967, DNR, January 4, 1968.
ENF72	= Fox River Valley Enforcement Conference (Summary of Pollution and Abatement Orders for Facilities on the Fox River) February 7-8, 1972.
DNR72	= Summary Report on Water Quality and Wastewater Discharge During the Summer of 1972, DNR WQES, 1972.
PERM73	= Current Discharges and Preliminary NPDES Permit Table, Duane Schuettpelz, DNR, 12/73.
PERM74	= Fox River Waste Loadings Sept 74 vs. Summer 72 Data Table, DNR, 1974.
SEMORE	= WPDES Self Monitoring Reports (monthly summaries for NRB), 1973-1981.
DMR	= WPDES Discharge Monitoring Report (electronic monthly summaries), 1982-6/97.
FWS	= U.S. Fish and Wildlife Service information collected through response to interrogatories.

Figure A-1: KIMBERLY CLARK CORPORATION-NEENAH/BADGER GLOBE

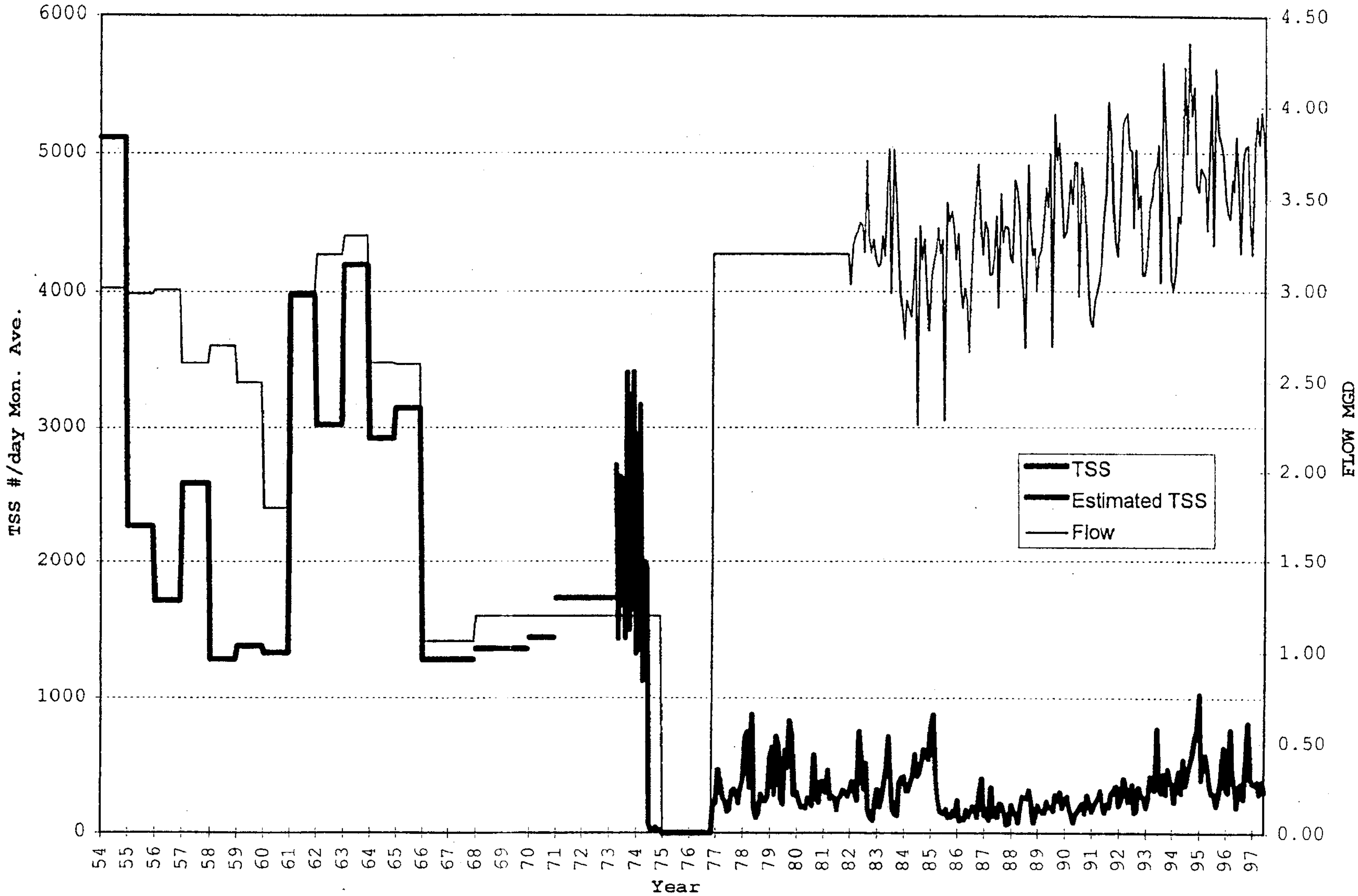


Figure A-2: PH GLATFELTER COMPANY

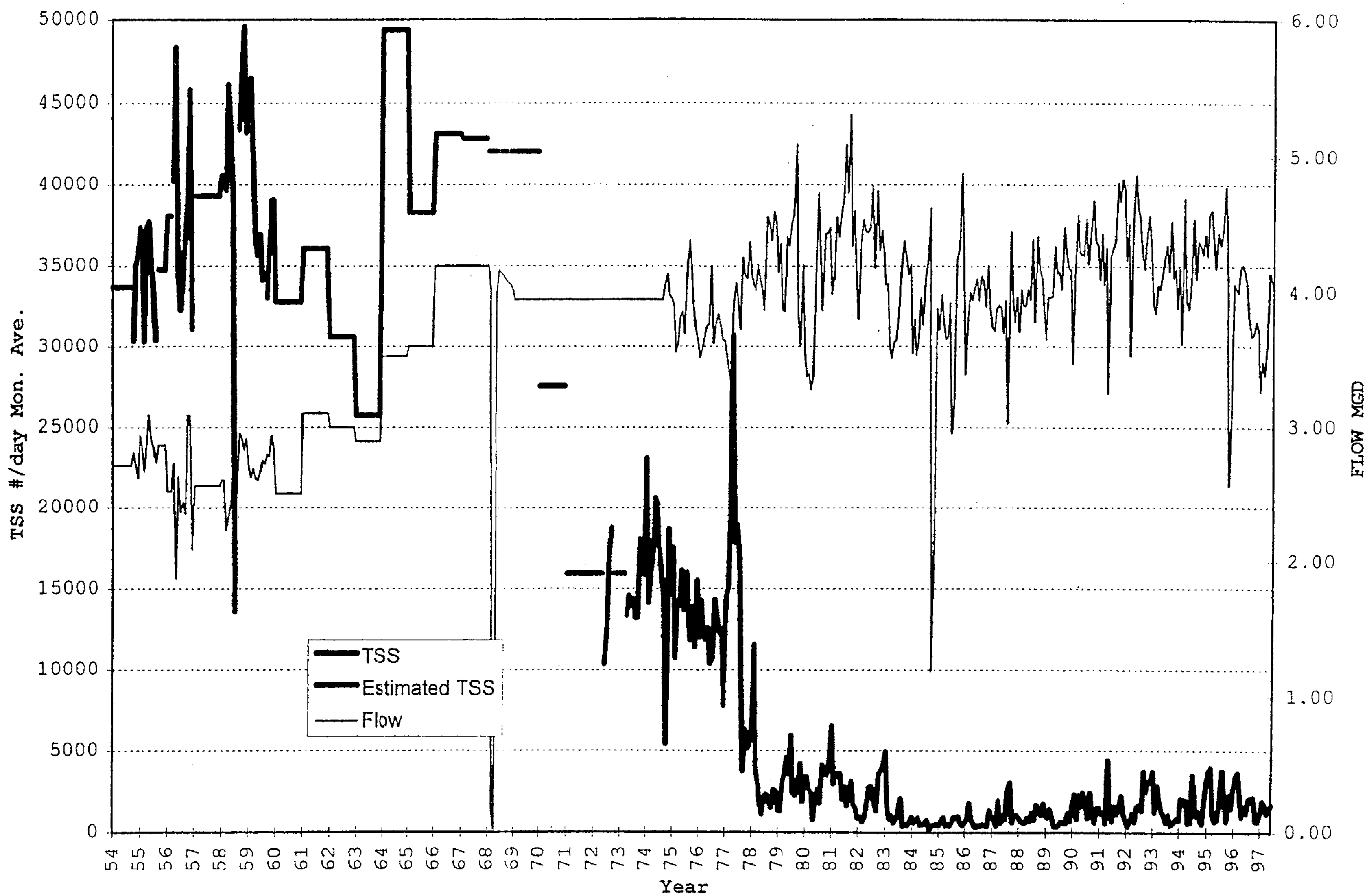


Figure A-3: AMERICAN TISSUE MILLS

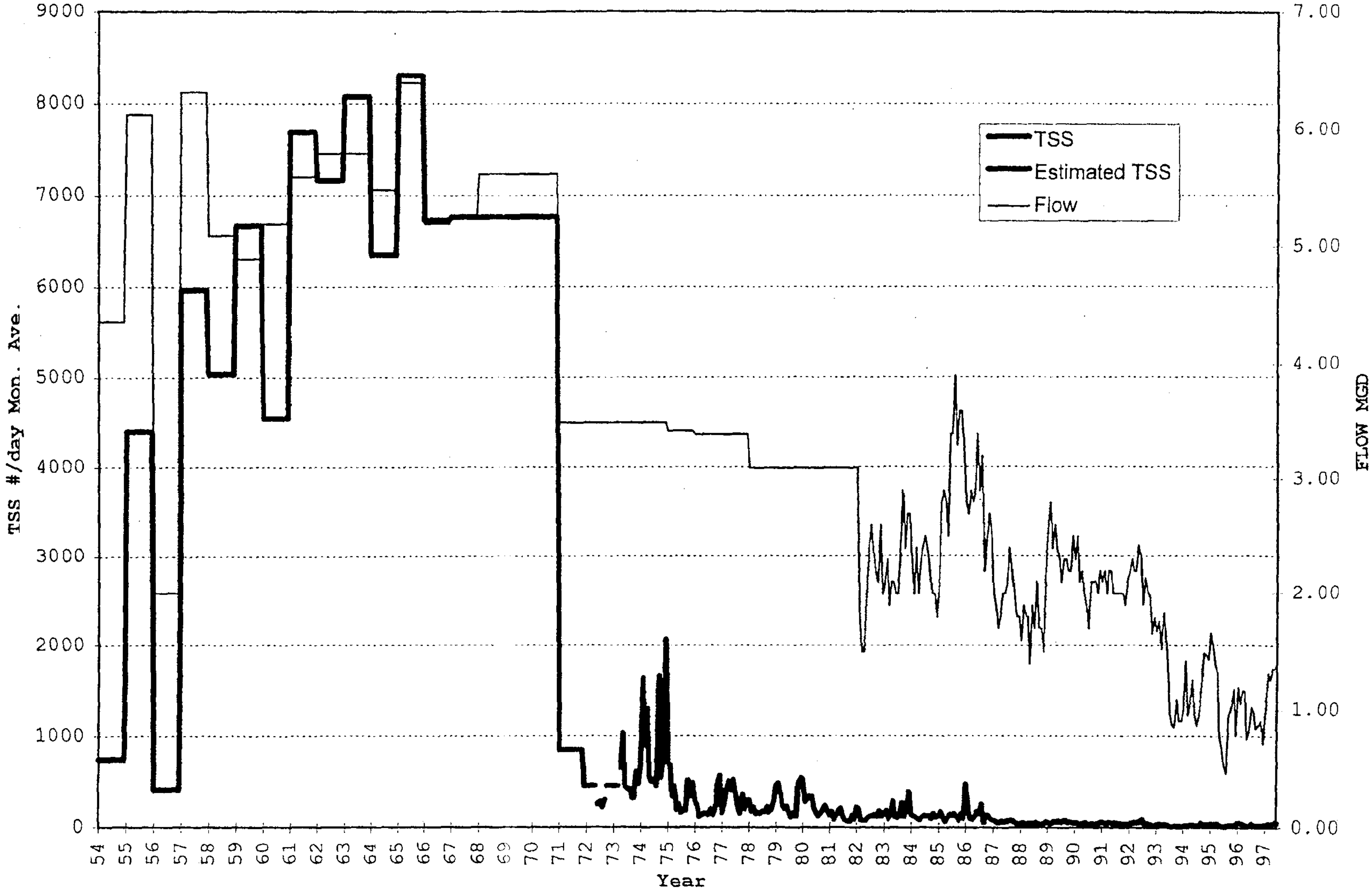


Figure A-4: AMERICAN CAN CANAL PLANT, MENASHA

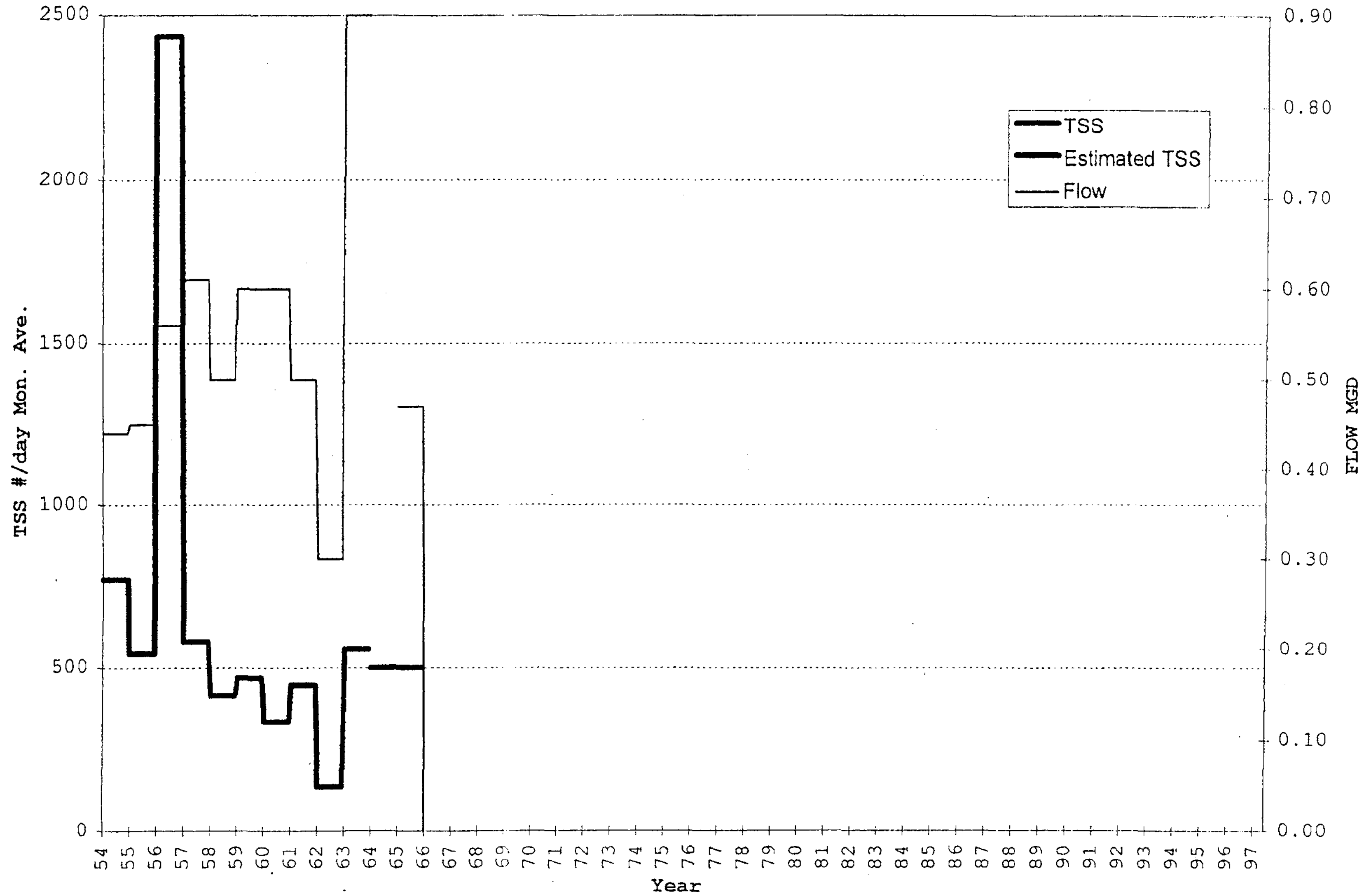


Figure A-5: US PAPER MILLS, MENASHA DIVISION

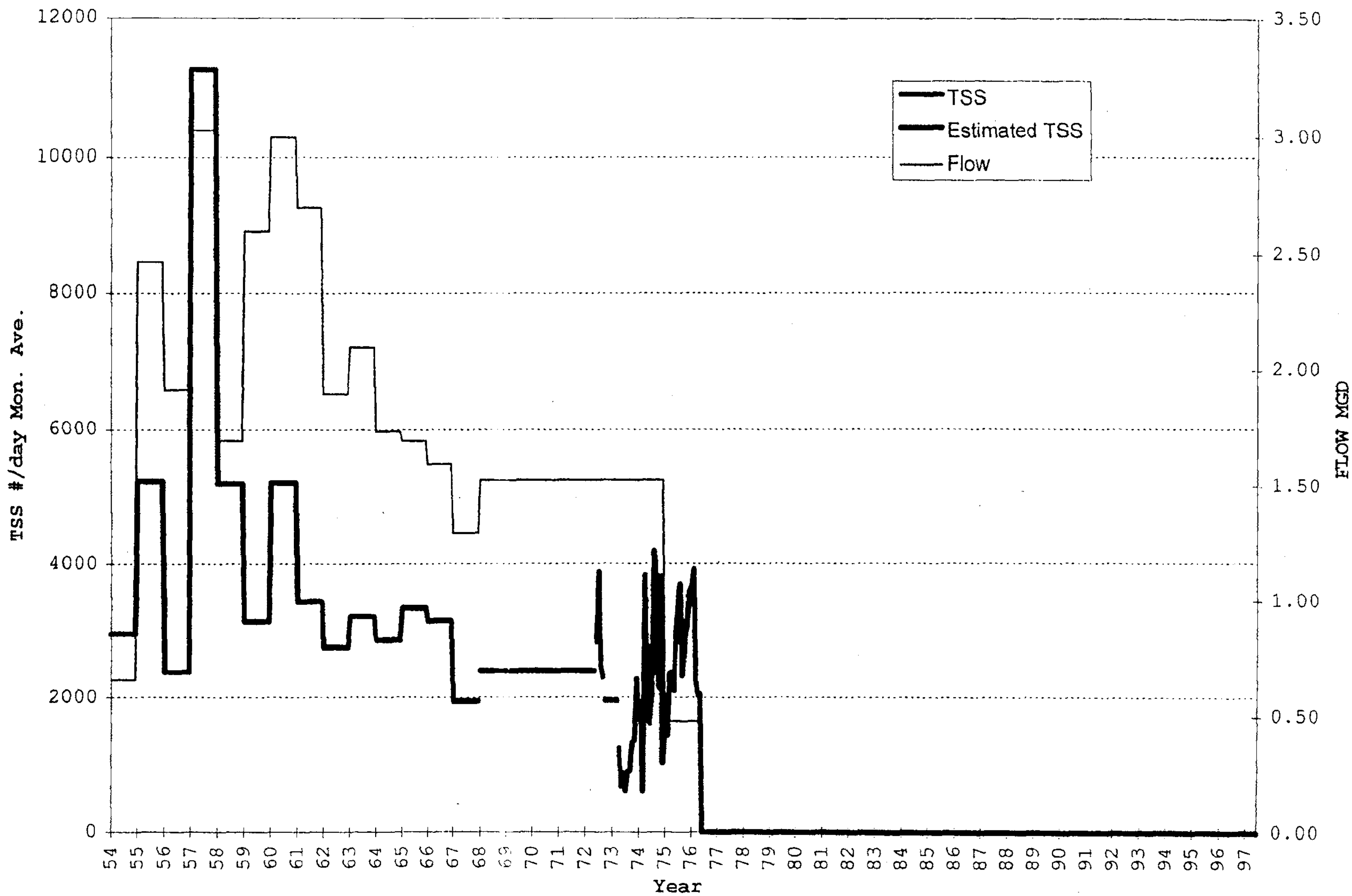


Figure A-6: MEAD CORPORATION, GILBERT PAPER DIVISION

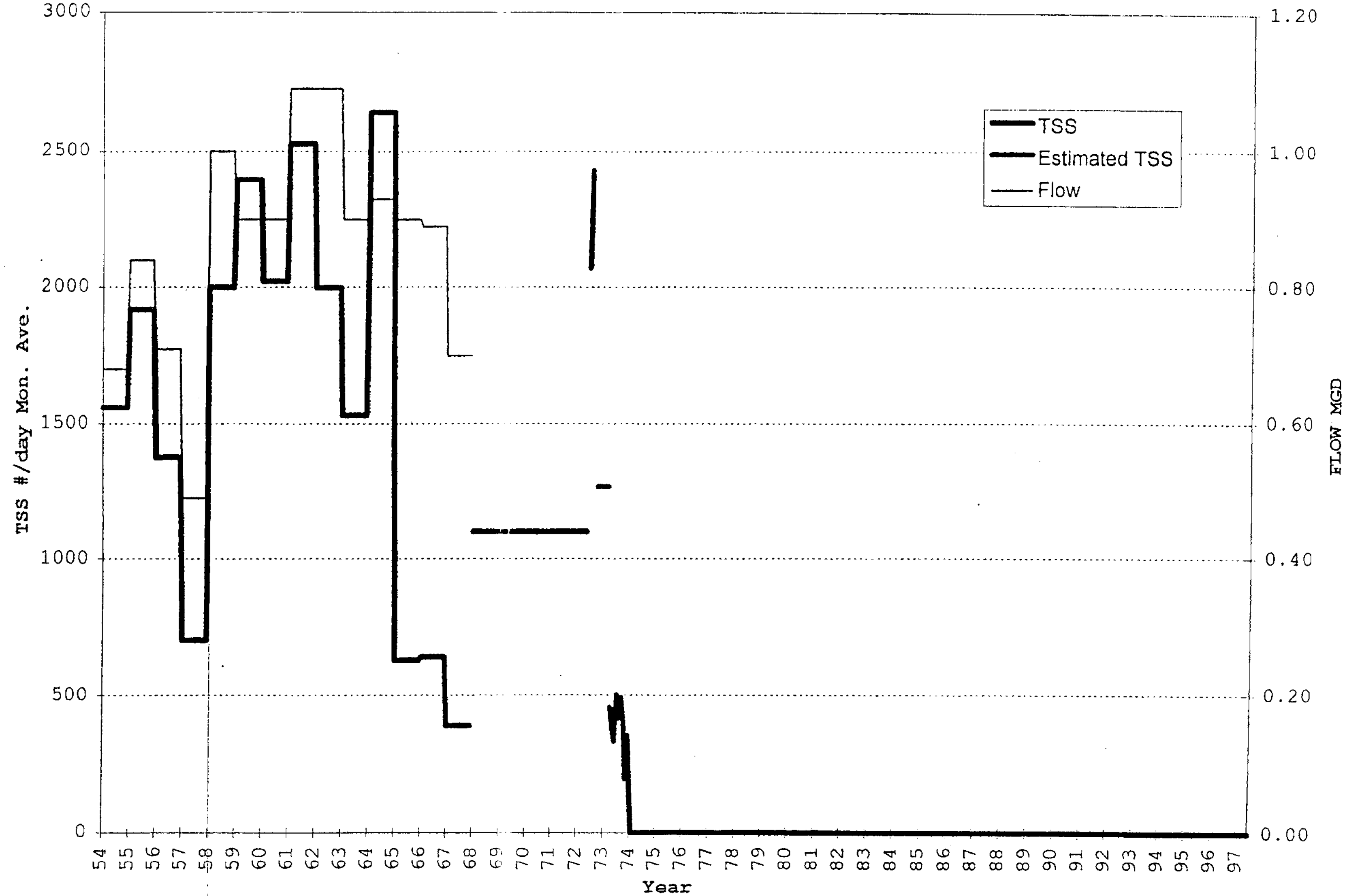


Figure A-7: GEORGE WHITING PAPER CORPORATION

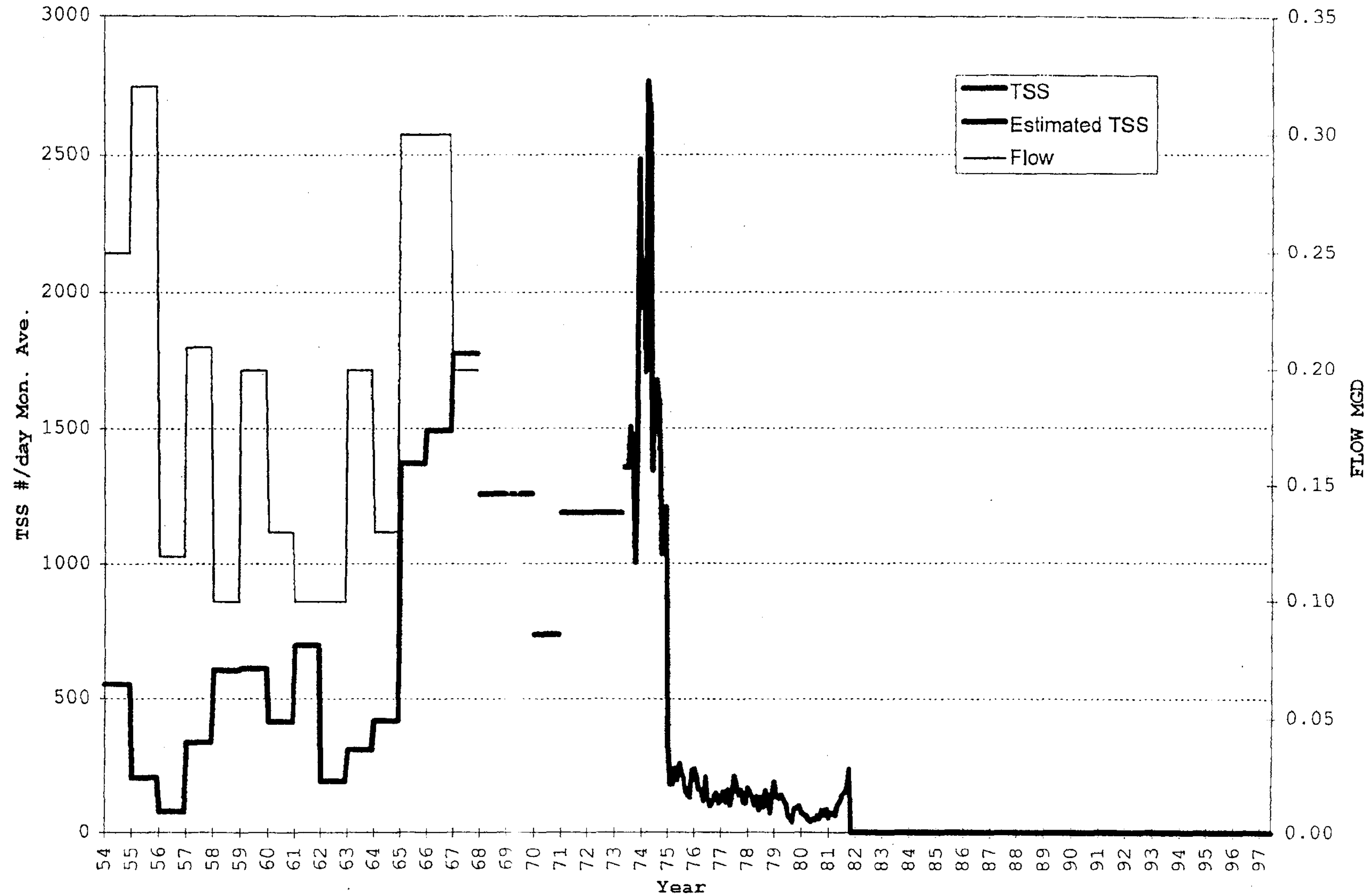


Figure A-8: WISCONSIN TISSUE MILLS

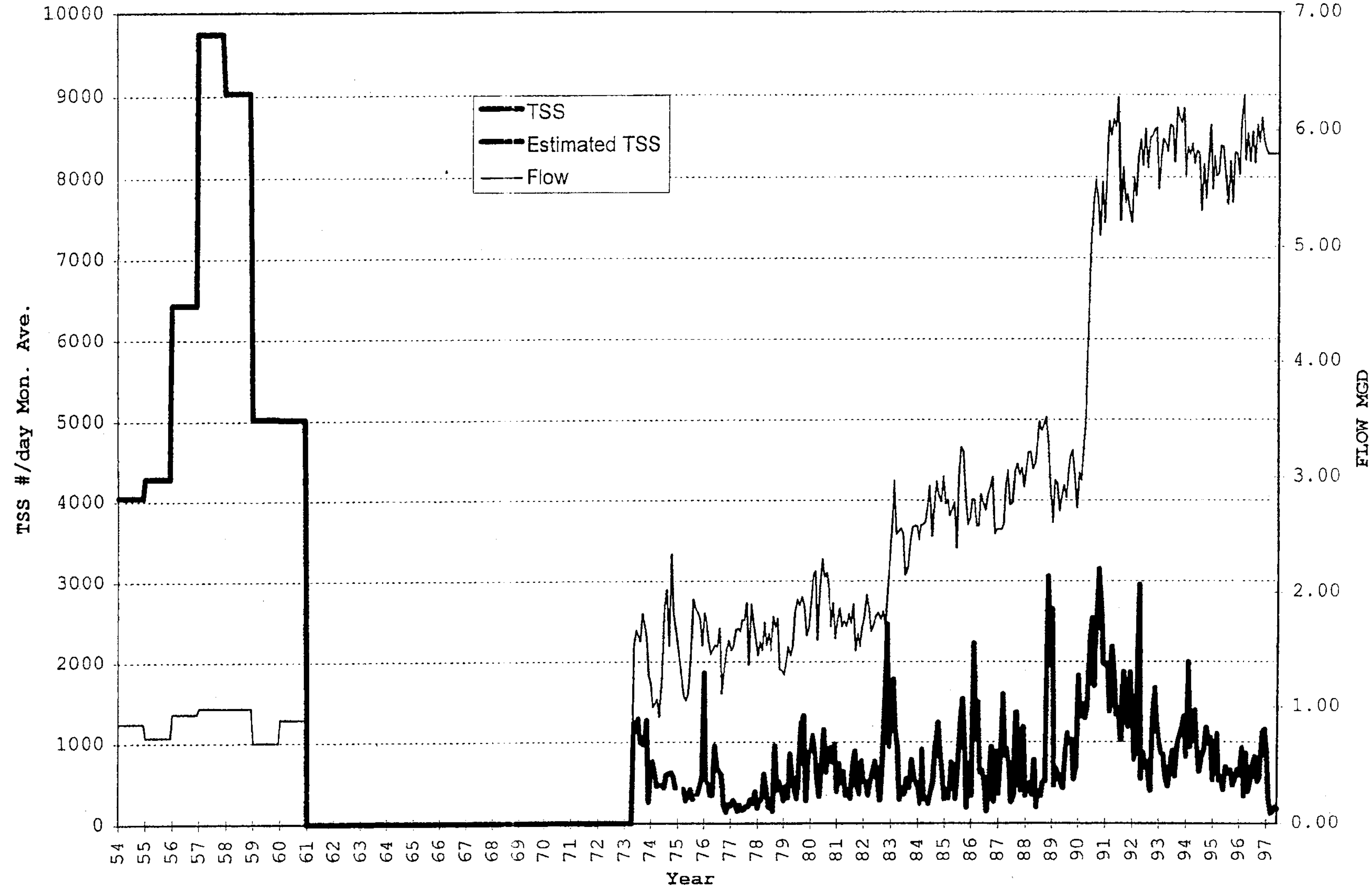


Figure A-9: RIVERSIDE PAPER CORPORATION, KERWIN DIVISION

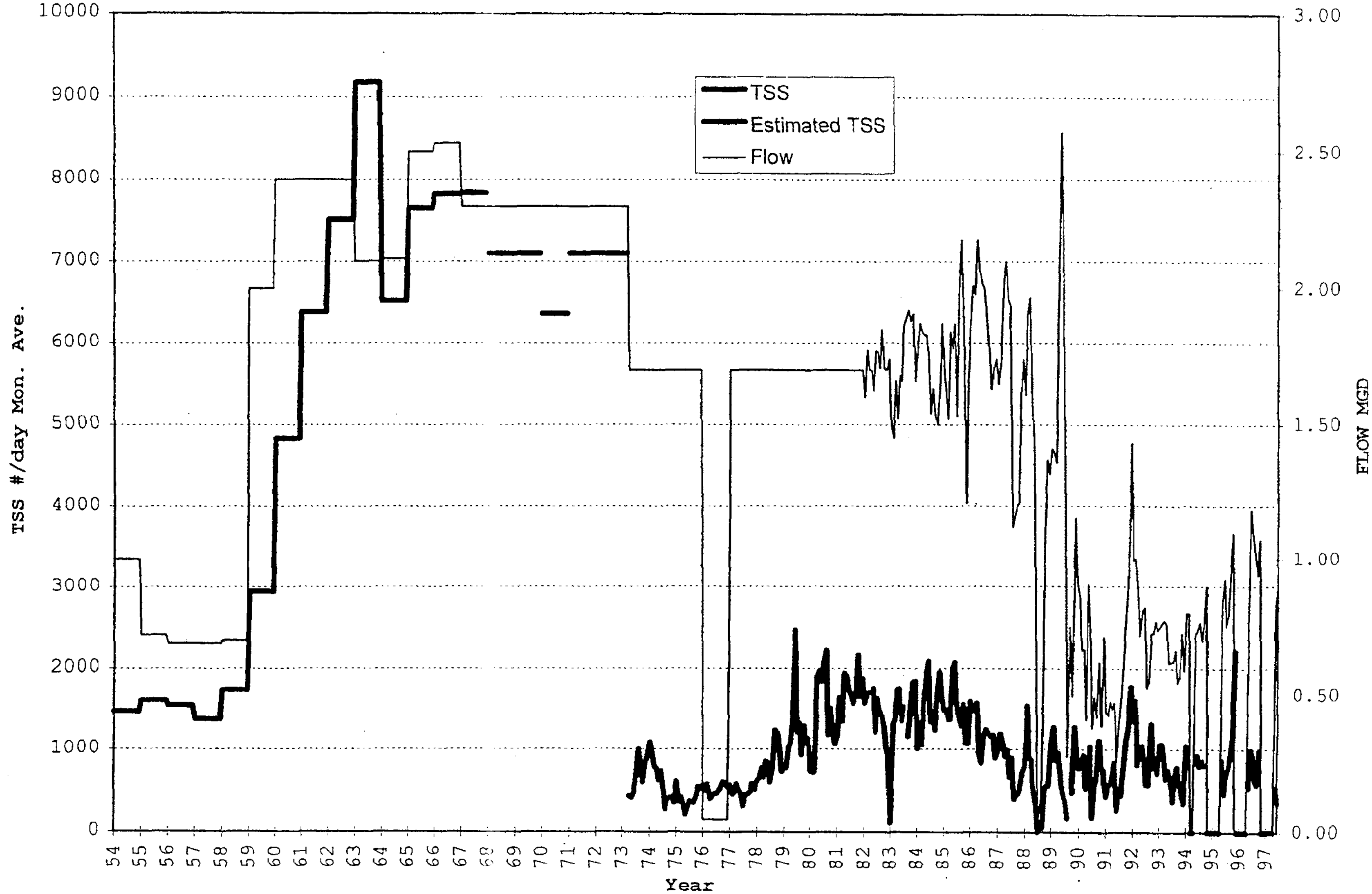


Figure A-10: CONSOLIDATED PAPER, APPLETON

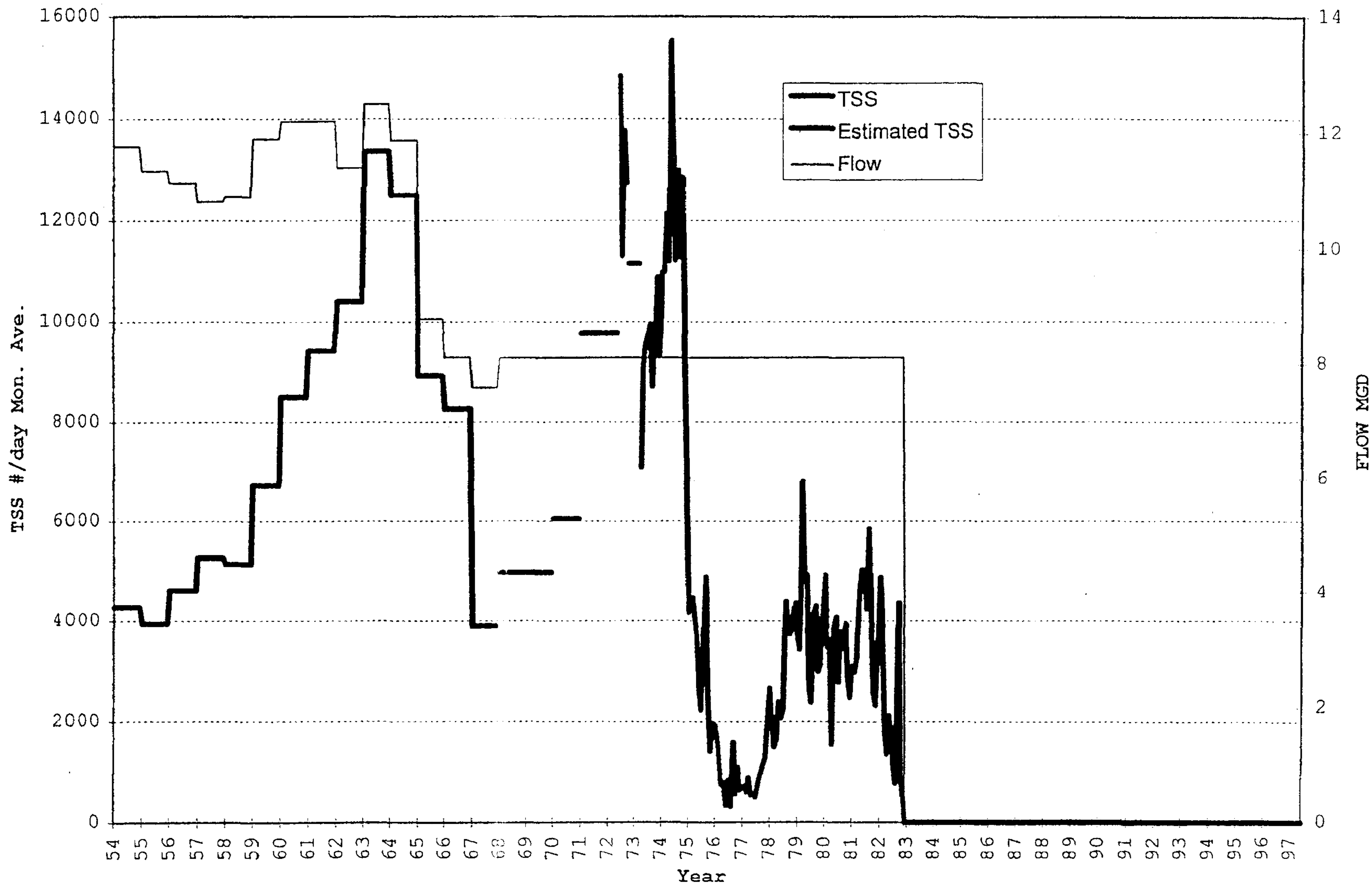


Figure A-11: CONSOLIDATED PAPER, INTER LAKE PAPER INC.

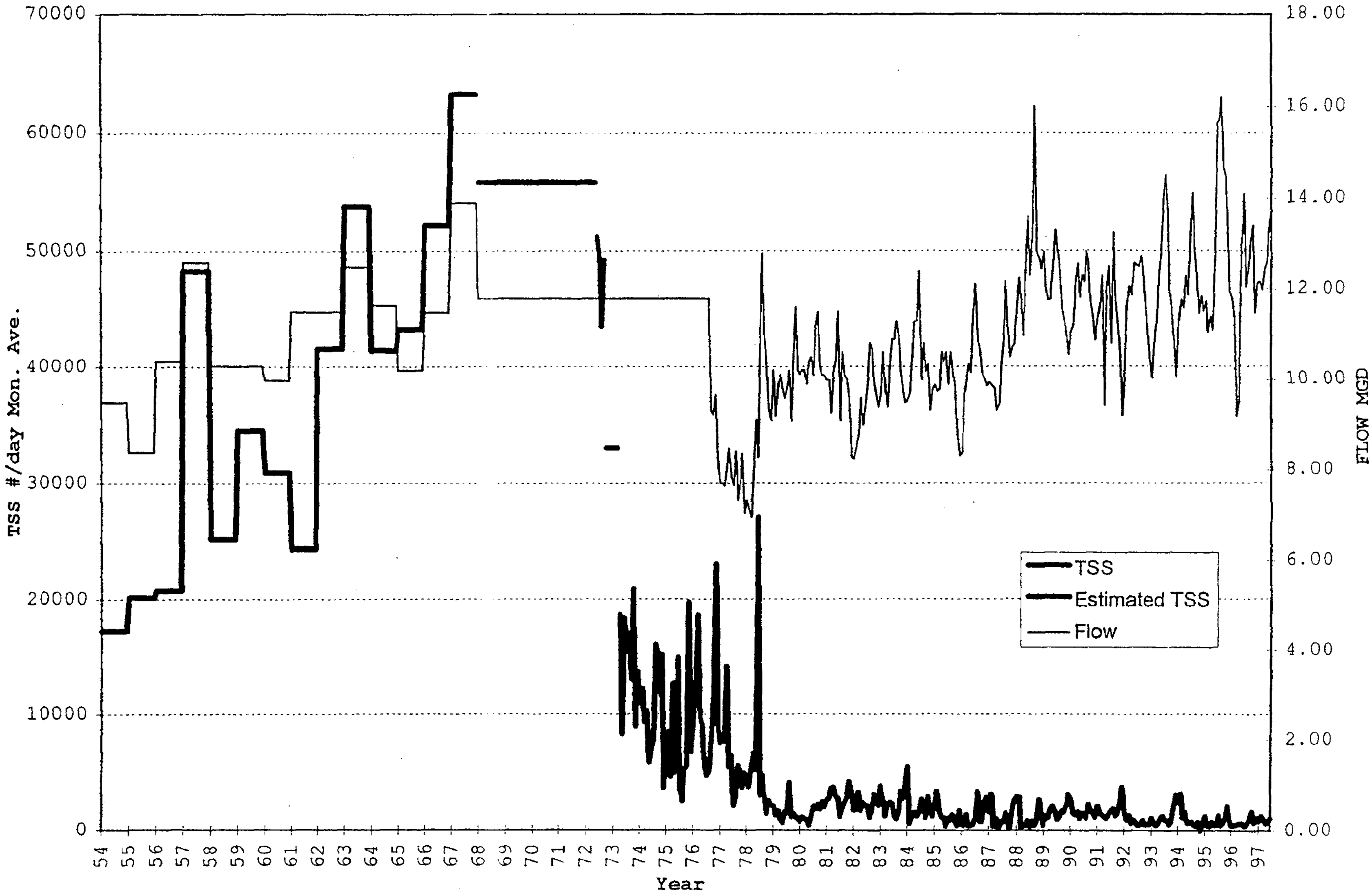


Figure A-12: APPLETON PAPERS - APPLETON COATING MILL

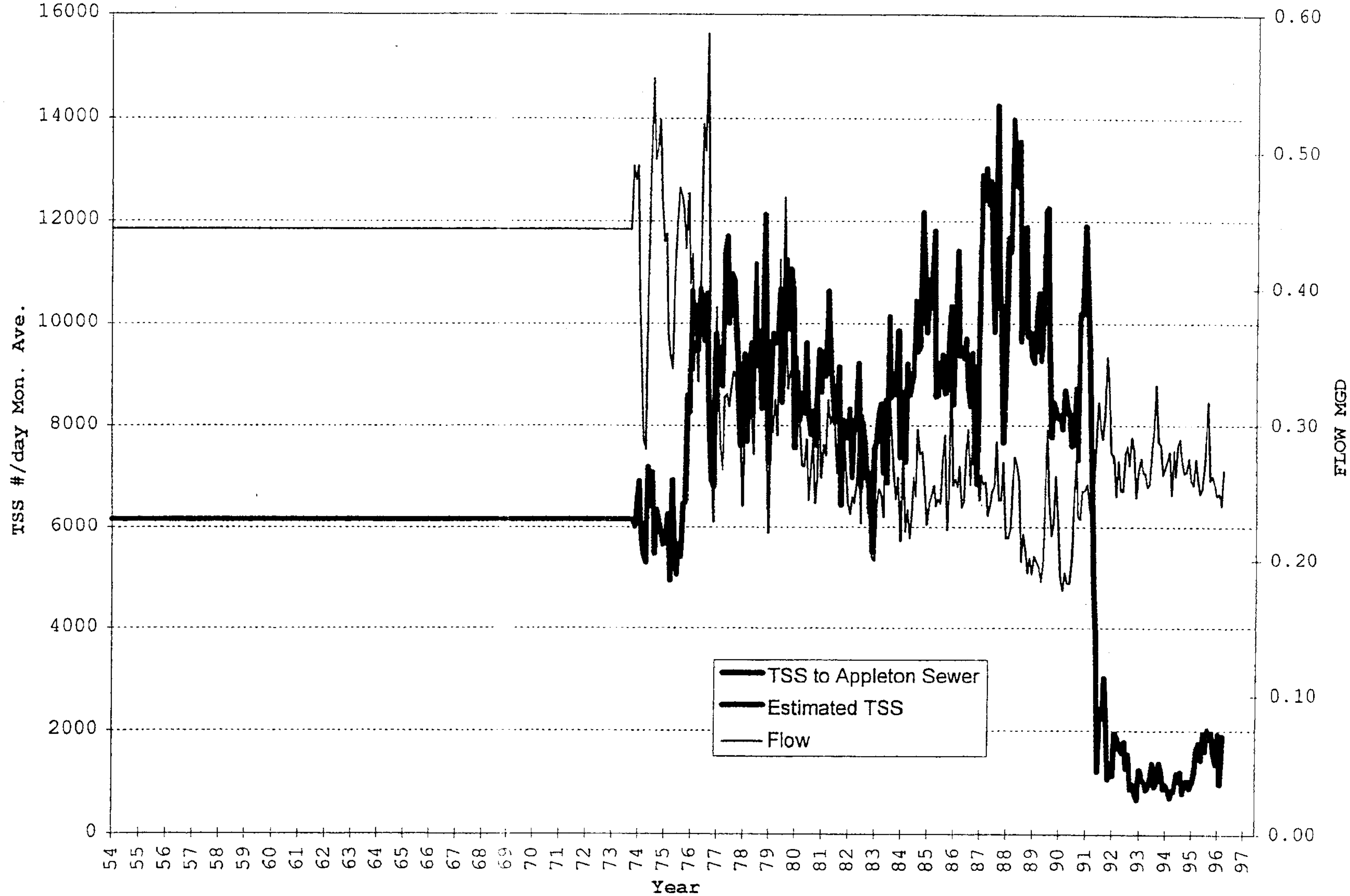


Figure A-13: APPLETON PAPERS INCORPORATED, LOCKS MILL

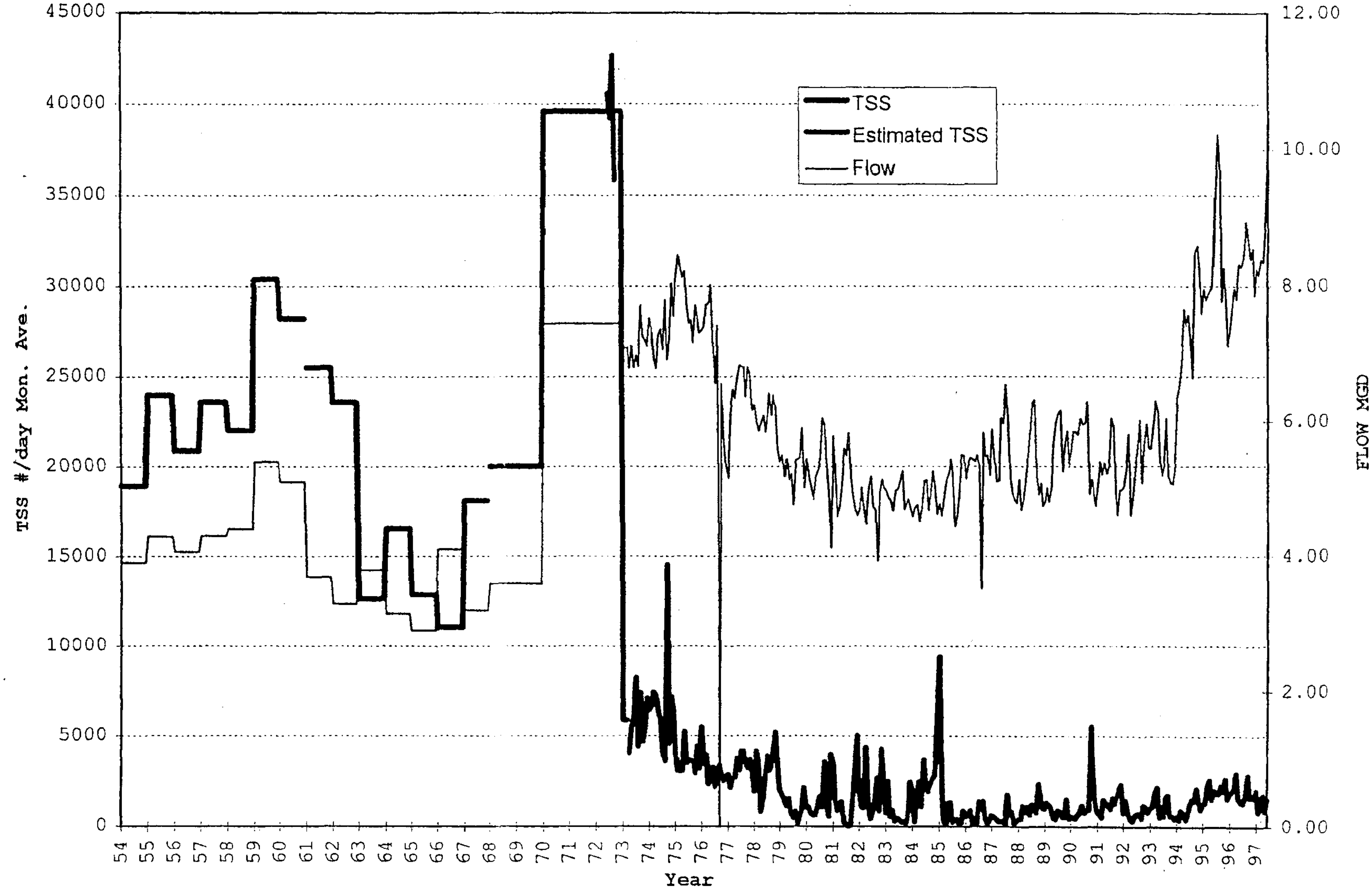


Figure A-14: INTERNATIONAL PAPER CORPORATION, THILMANY DIVISION

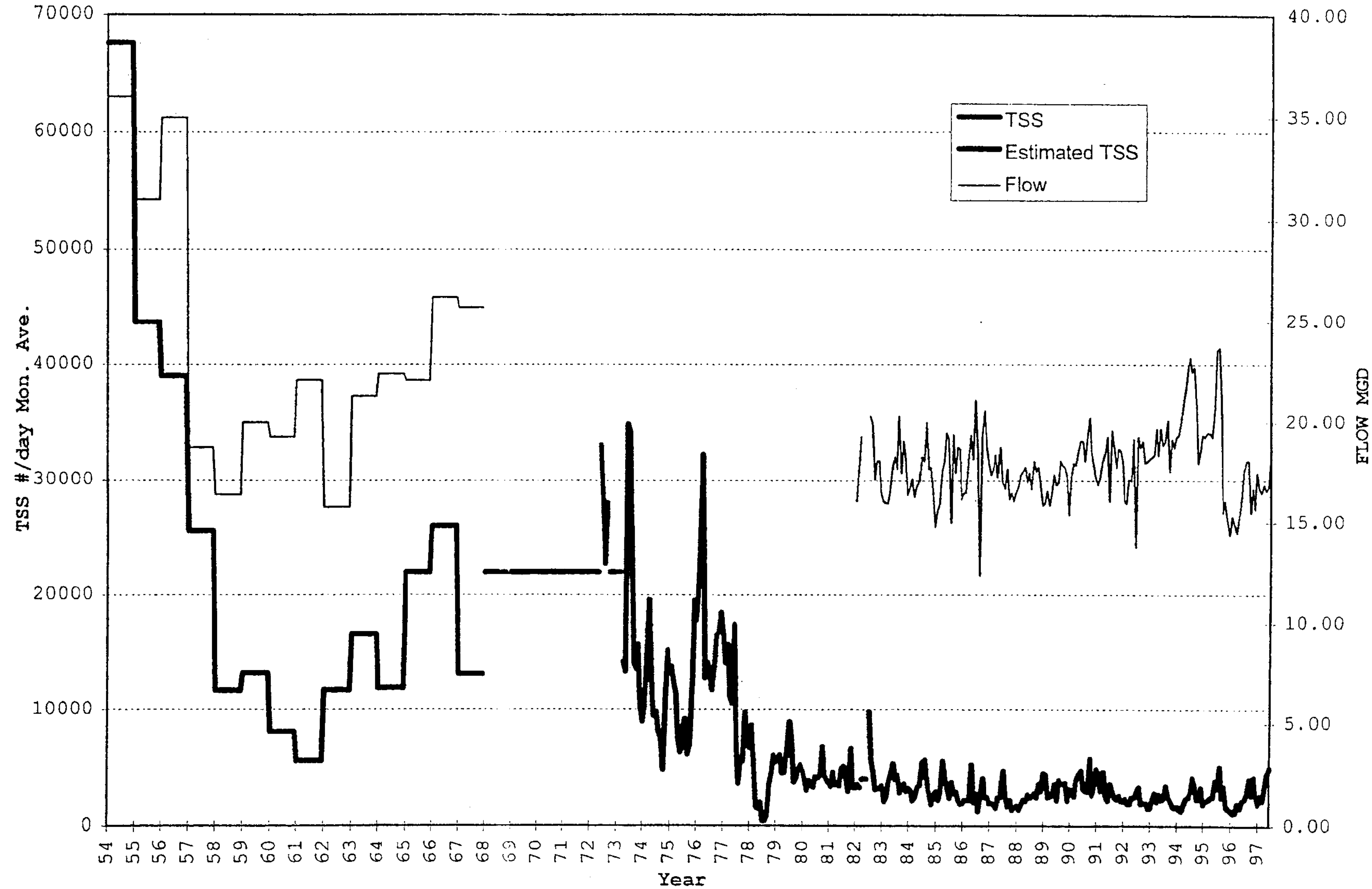


Figure A-15: CHARMIN-LITTLE RAPIDS MILL

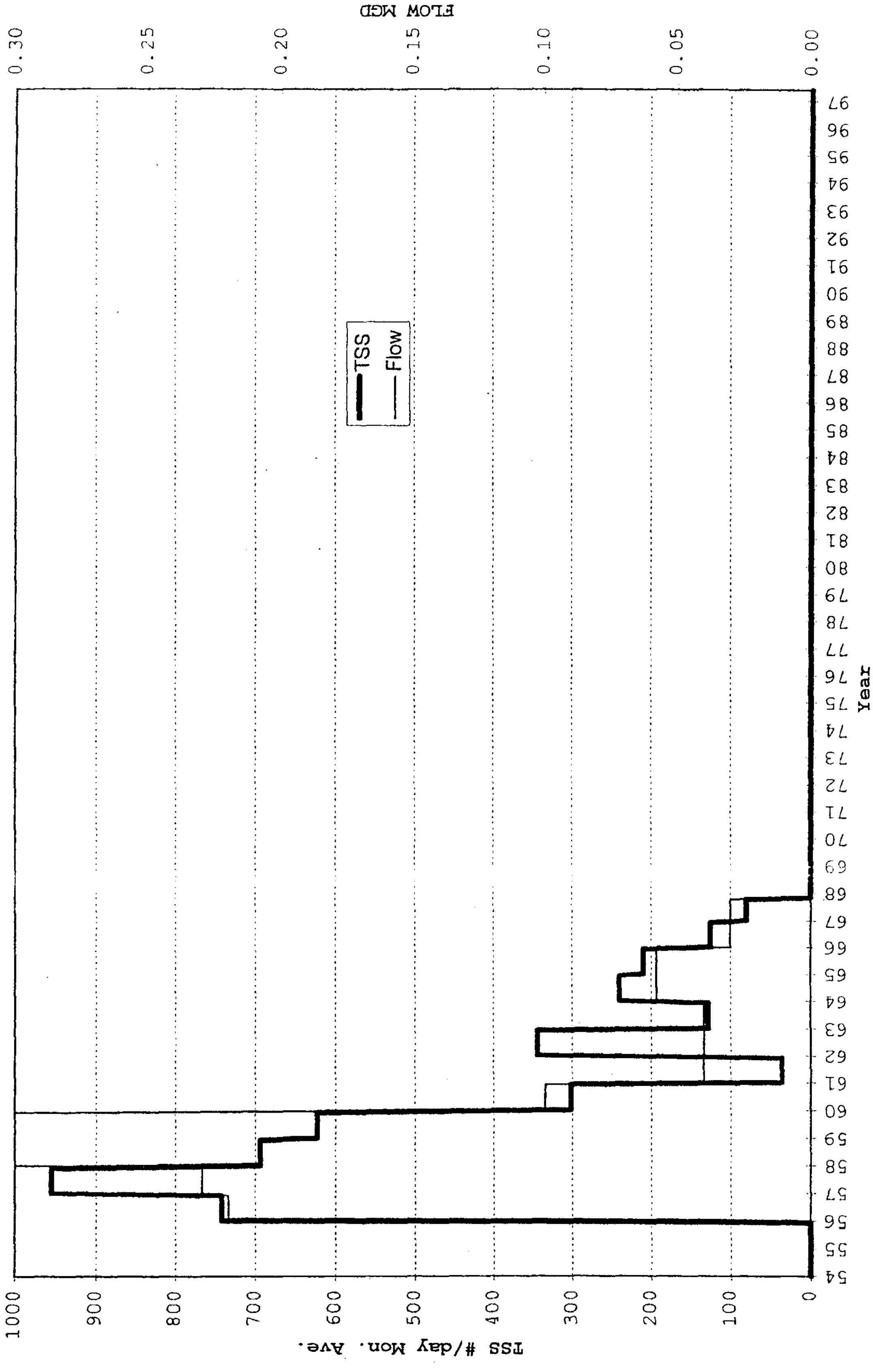


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Figure A-16: INTERNATIONAL PAPER CORPORATION, NICOLET DIVISION

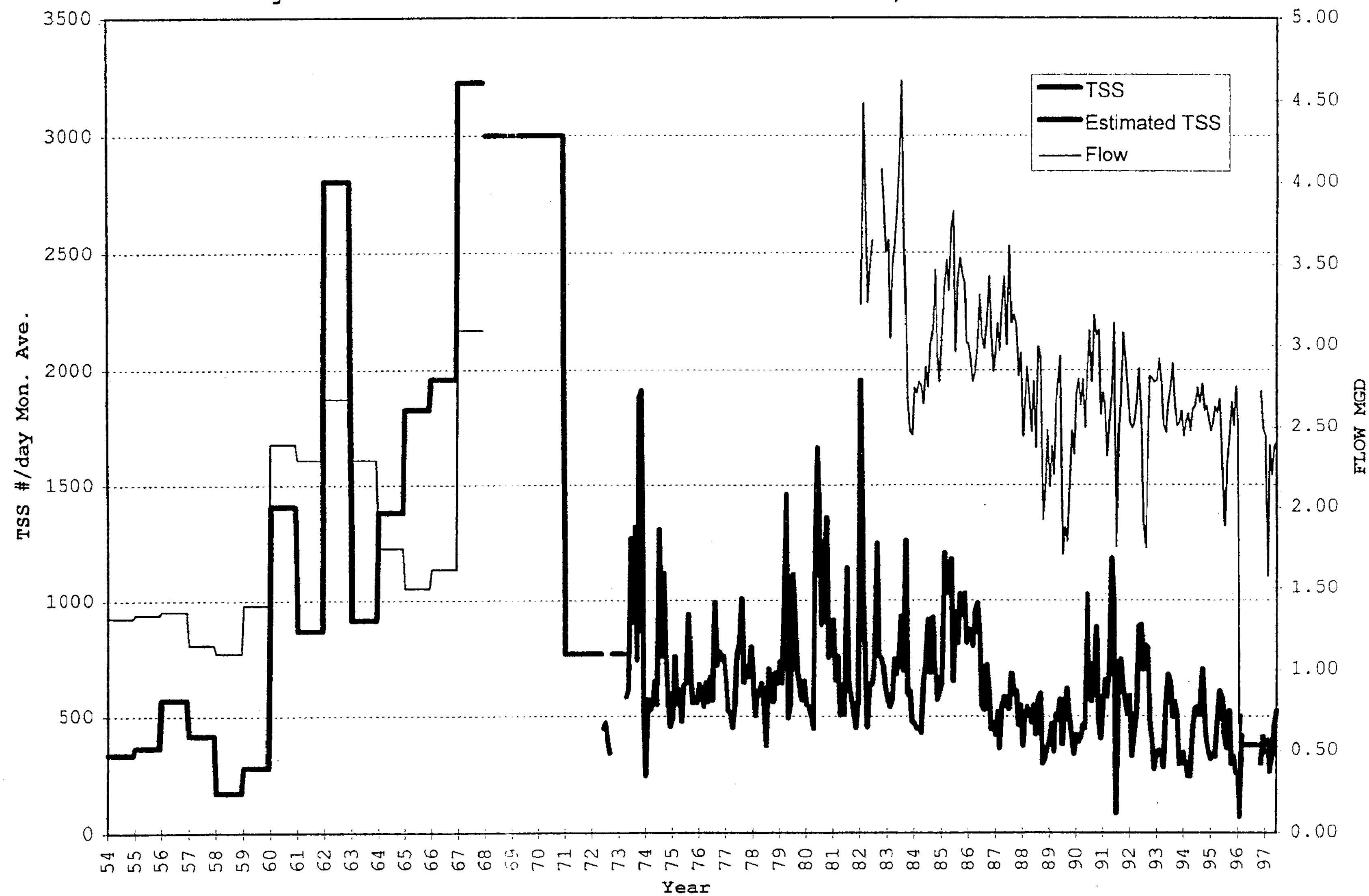

Figure A-17: US PAPER MILLS CORPORATION, DEPERE DIVISION

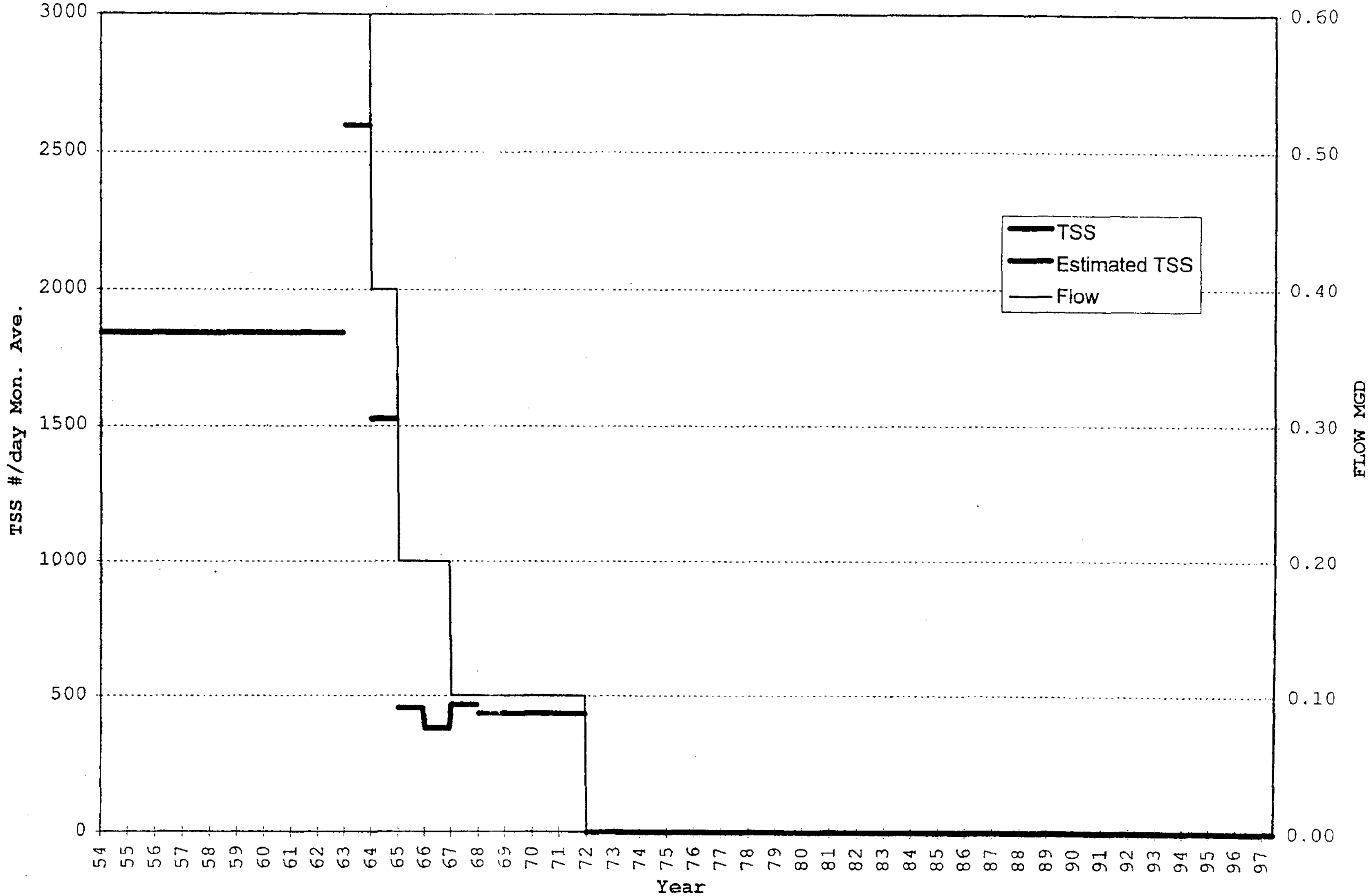

Figure A-18: FT. JAMES CORPORATION, GREEN BAY WEST MILL

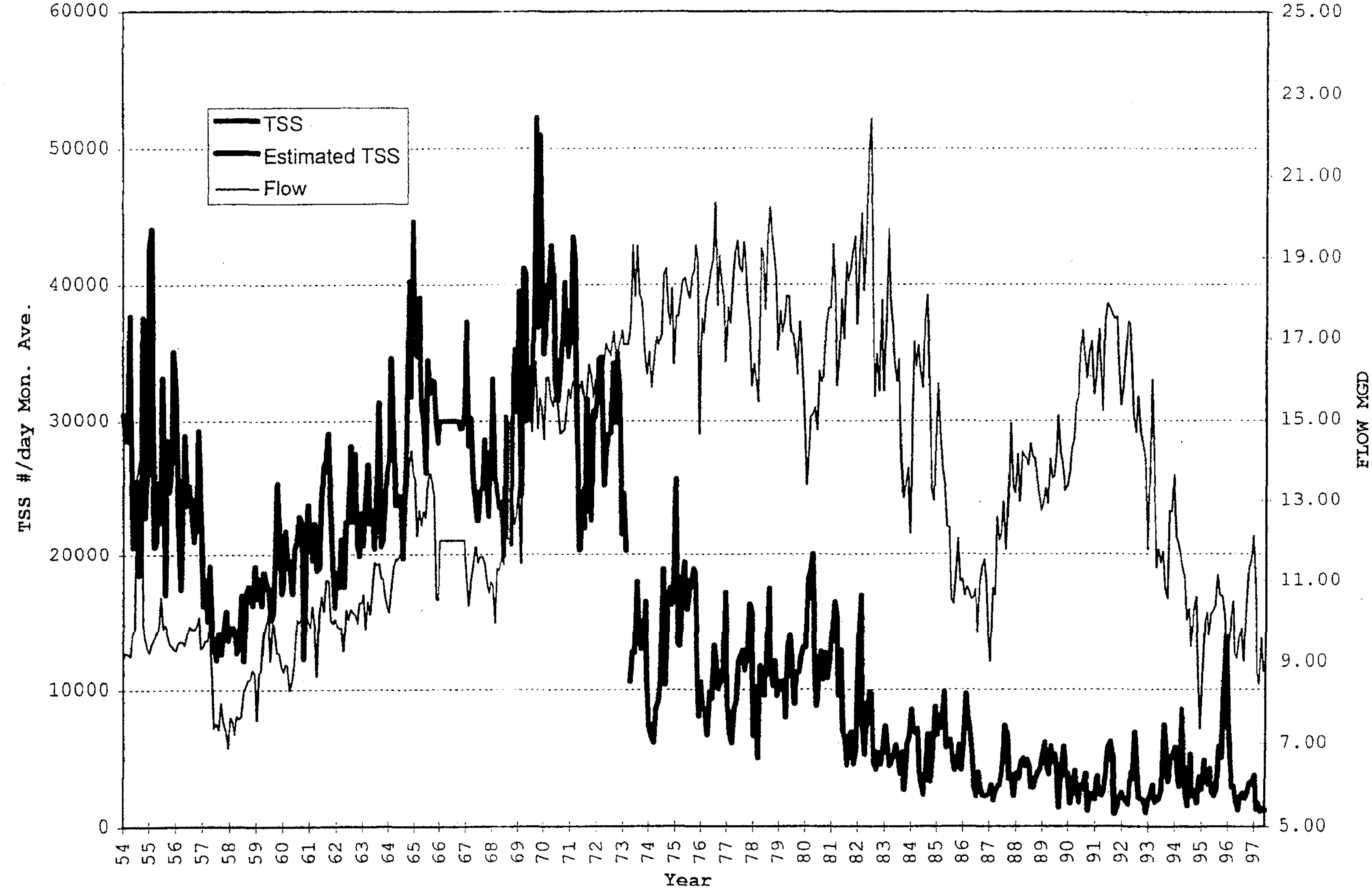

Figure A-19: PROCTER & GAMBLE PAPER PRODUCTS COMPANY

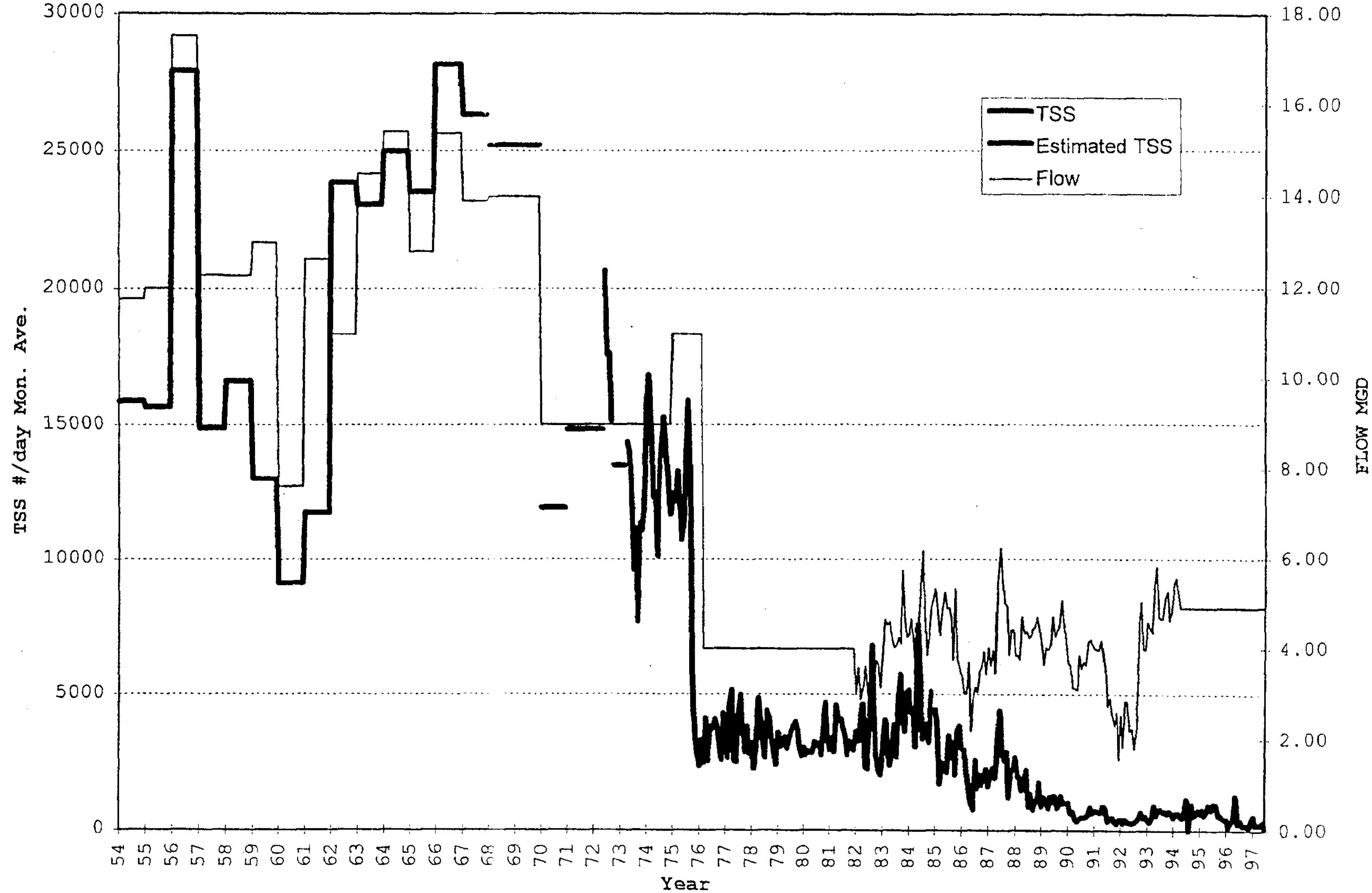

Figure A-20: GREEN BAY PACKAGING INCORPORATED

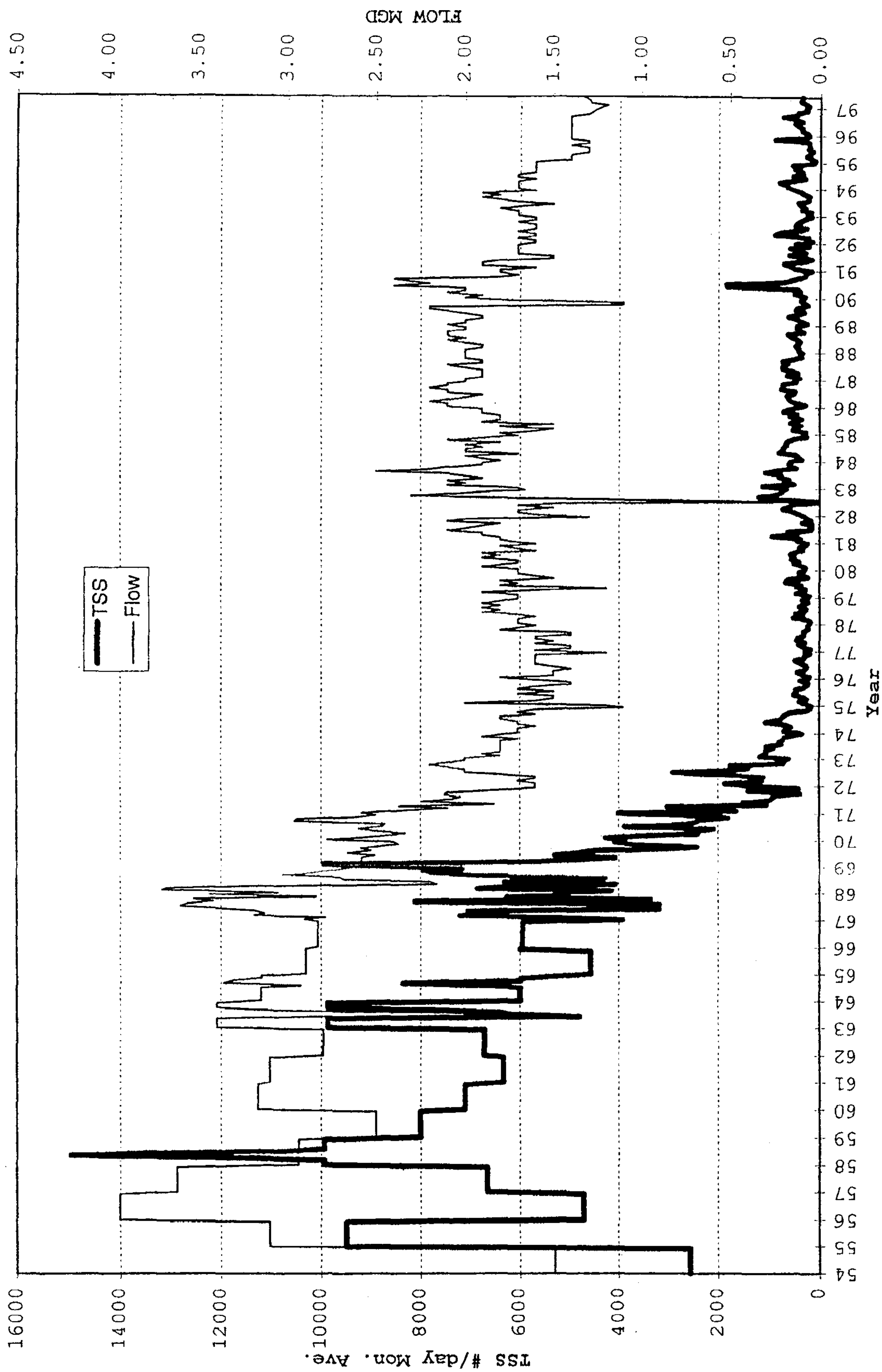

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Figure A-21: FT. JAMES CORPORATION, GREEN BAY EAST MILL

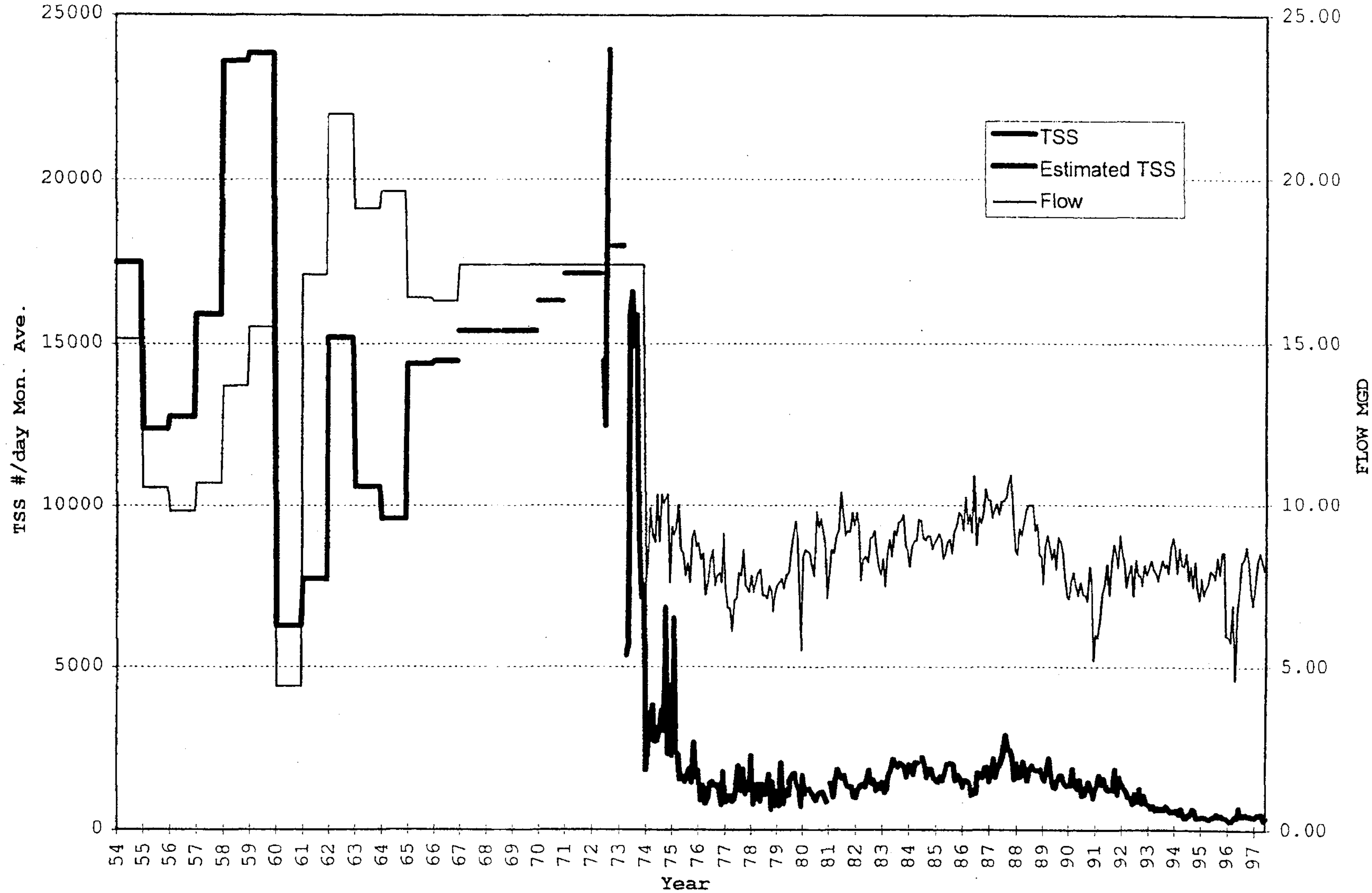


Figure A-22: NEENAH MENASHA POTW

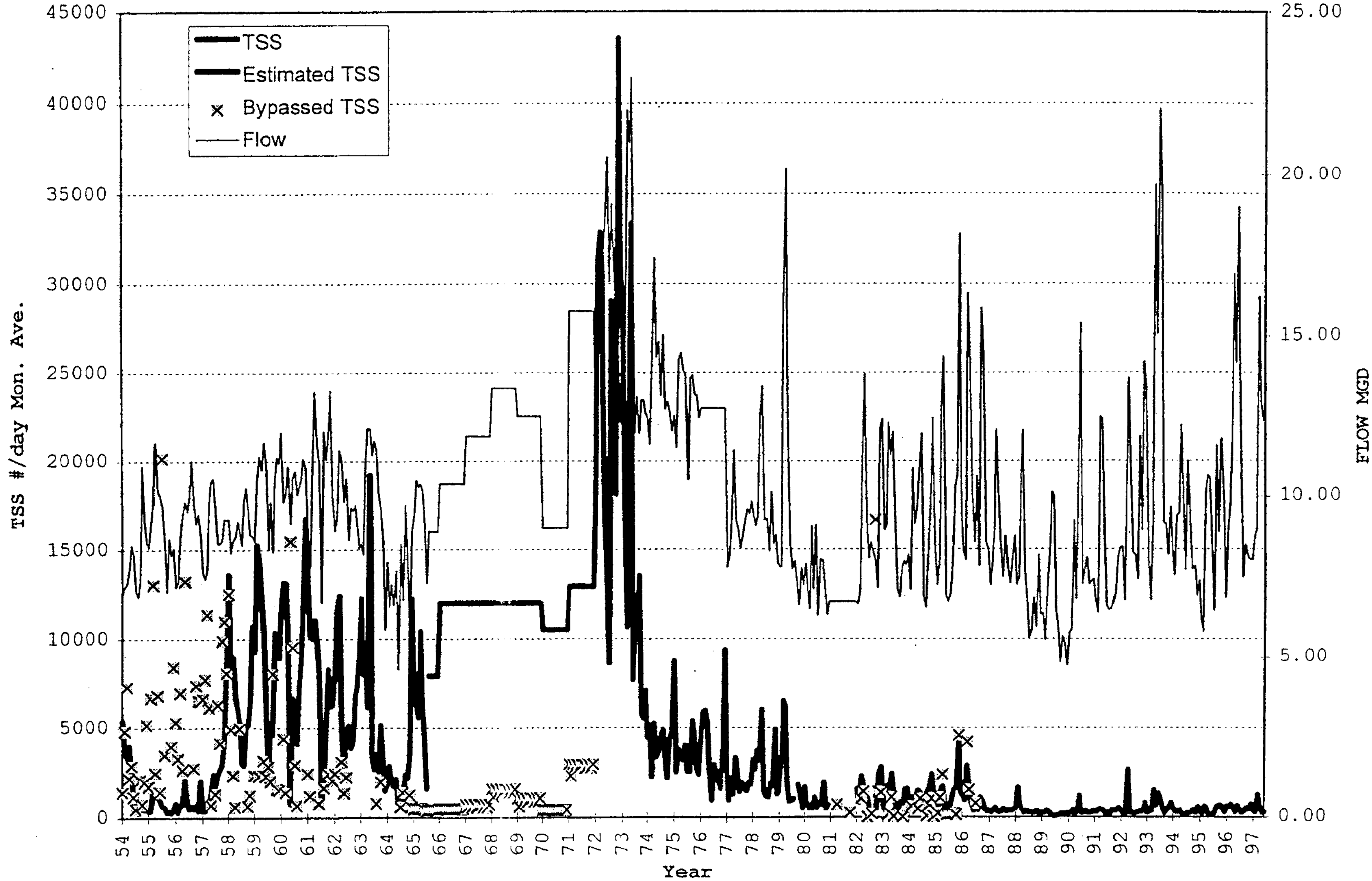


Figure A-23: MENASHA S. D. EAST

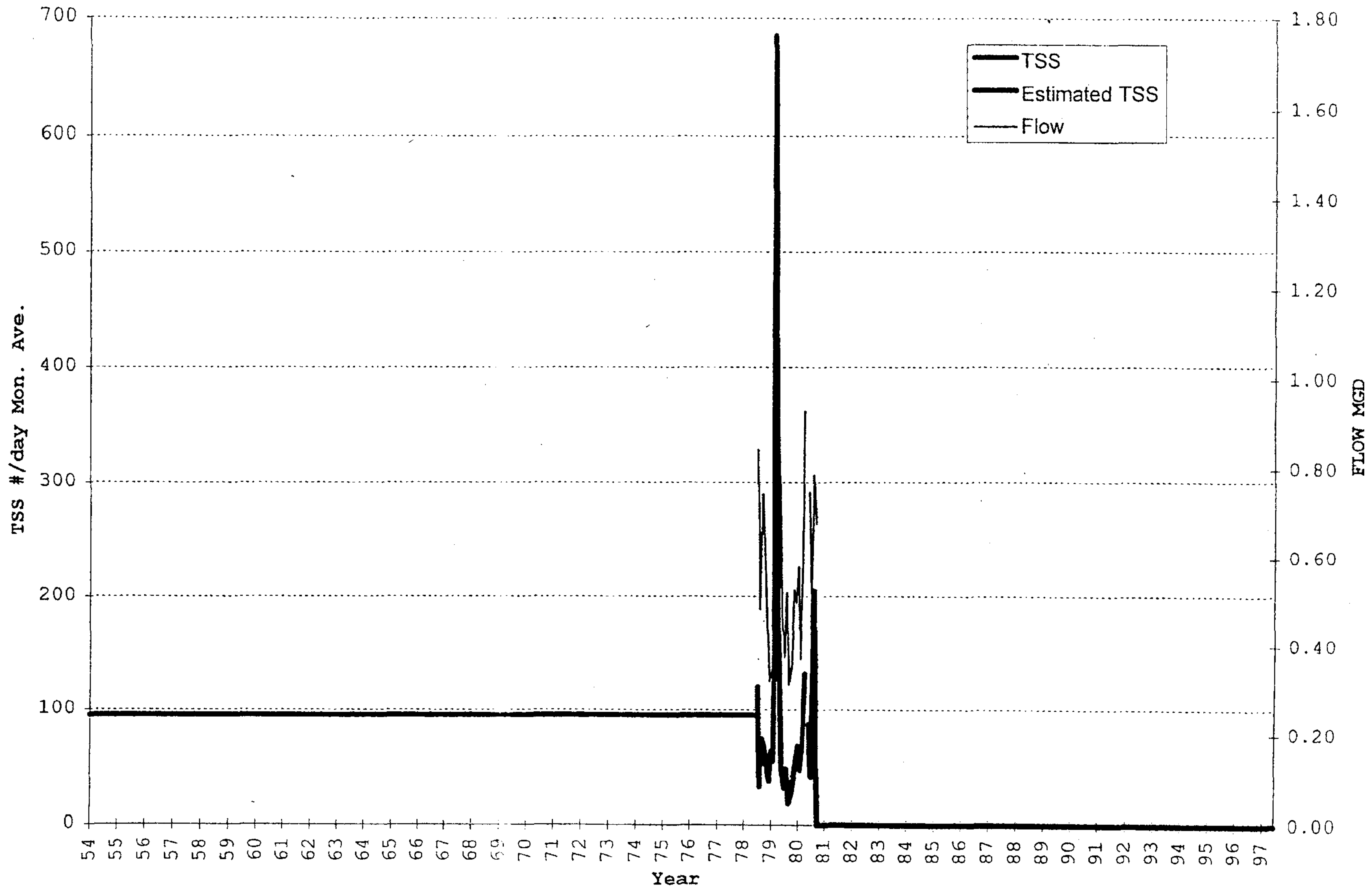


Figure A-24: GRAND CHUTE/MENASHA WEST POTW

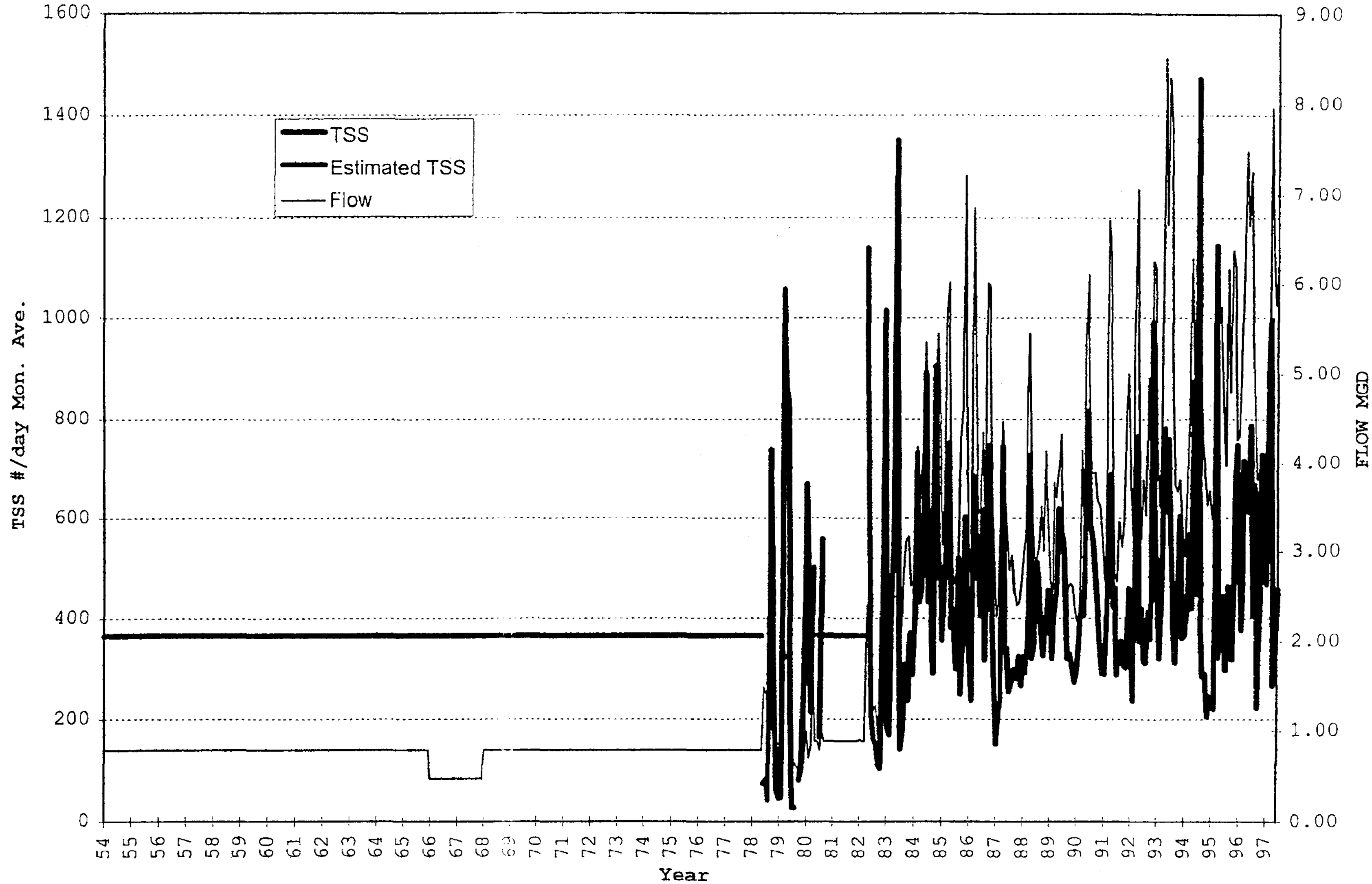


Figure A-25: APPLETON POTW

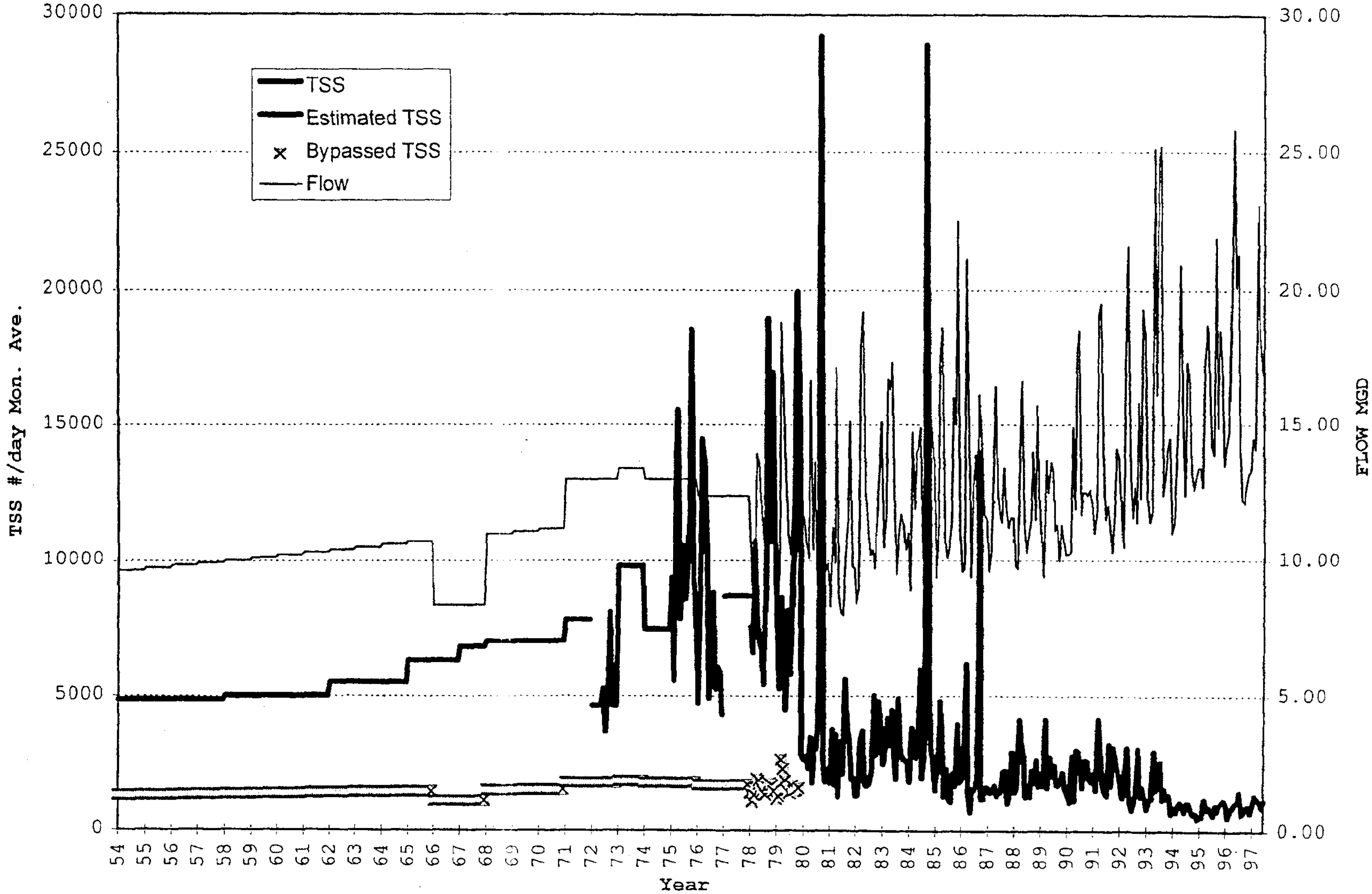


Figure A-26: KIMBERLY STP

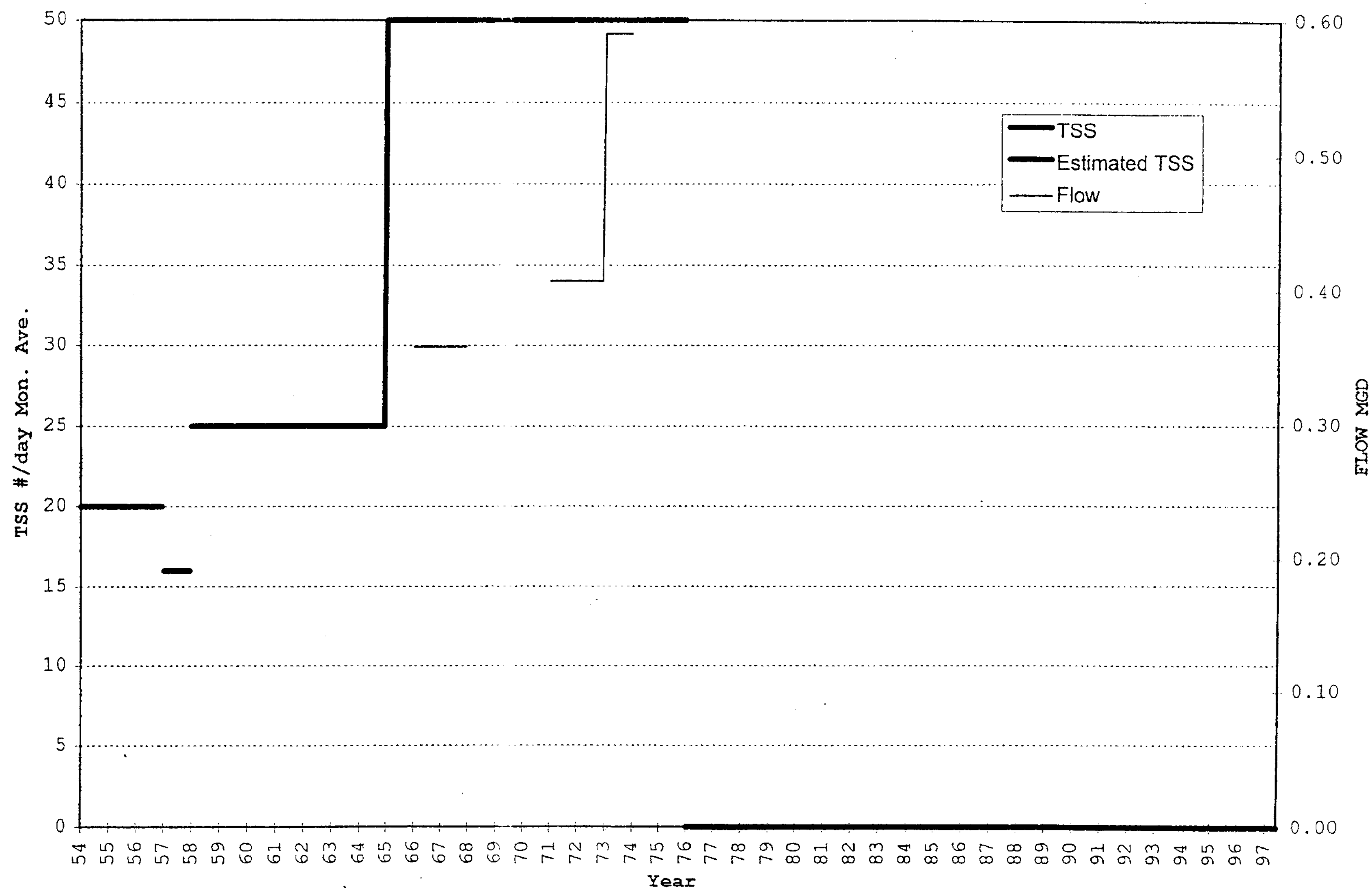


Figure A-27: LITTLE CHUTE STP

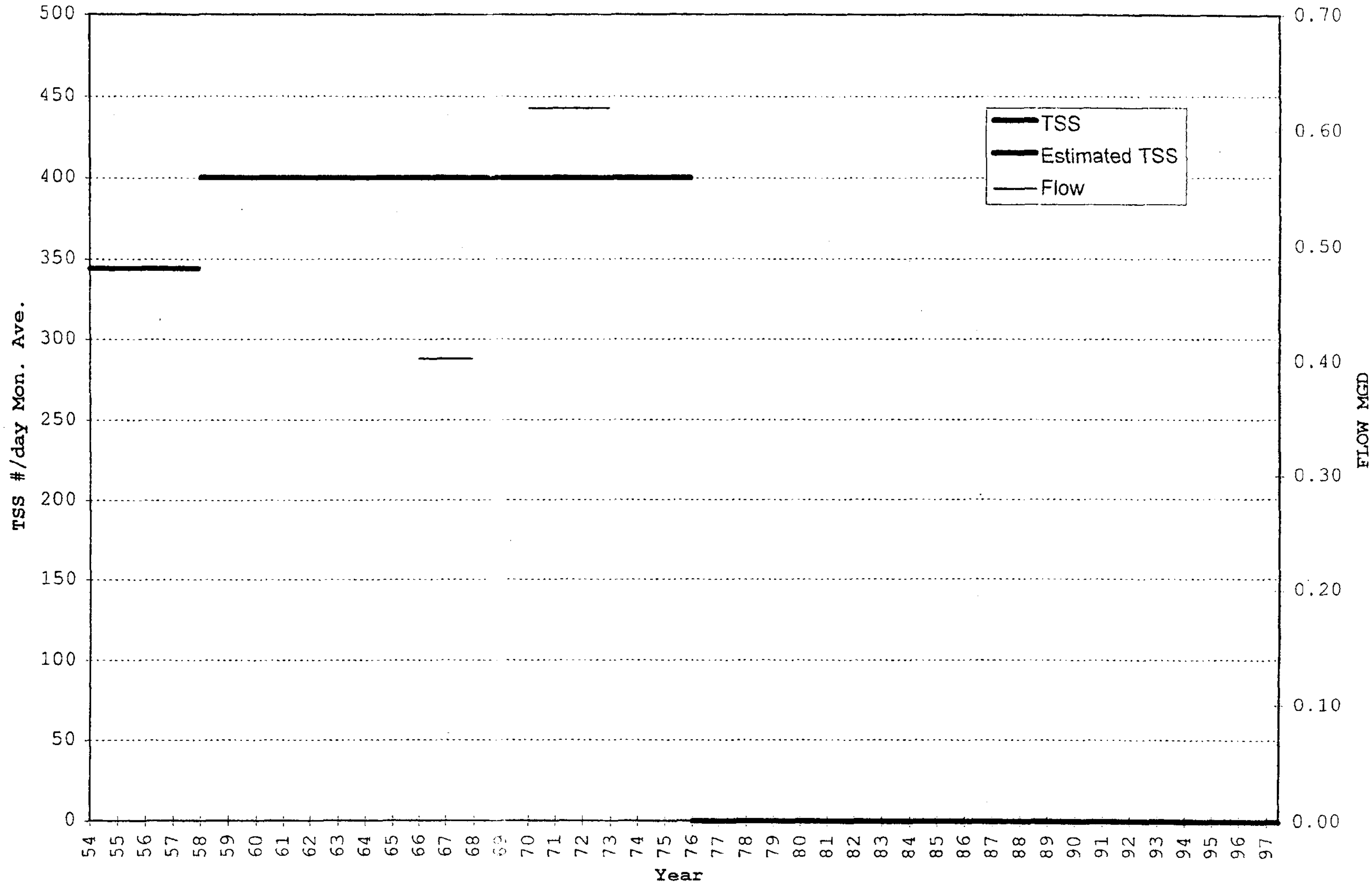


Figure A-28: HEART OF THE VALLEY (KAUKAUNA) POTW

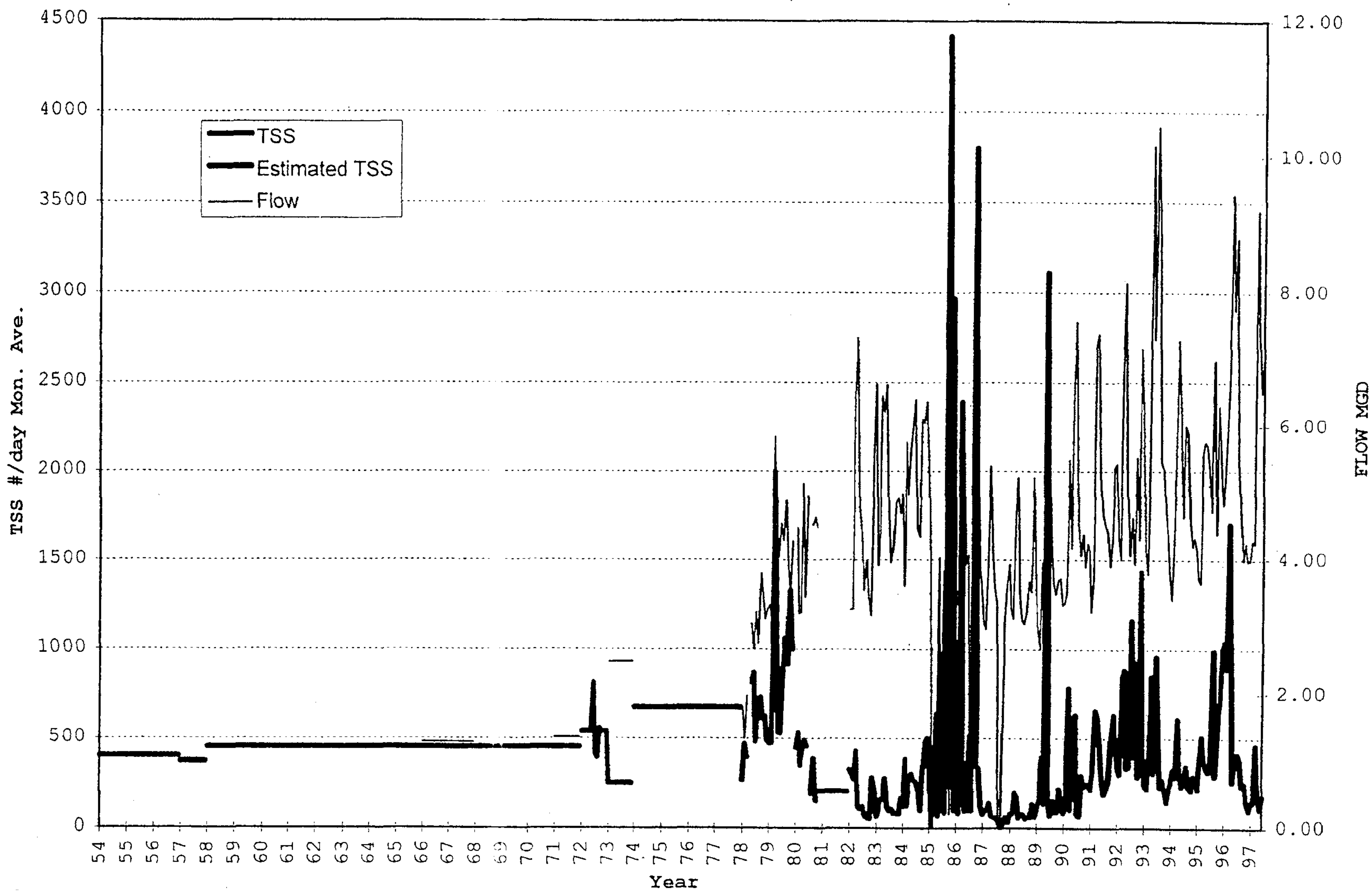


Figure A-29: WRIGHTSTOWN STP

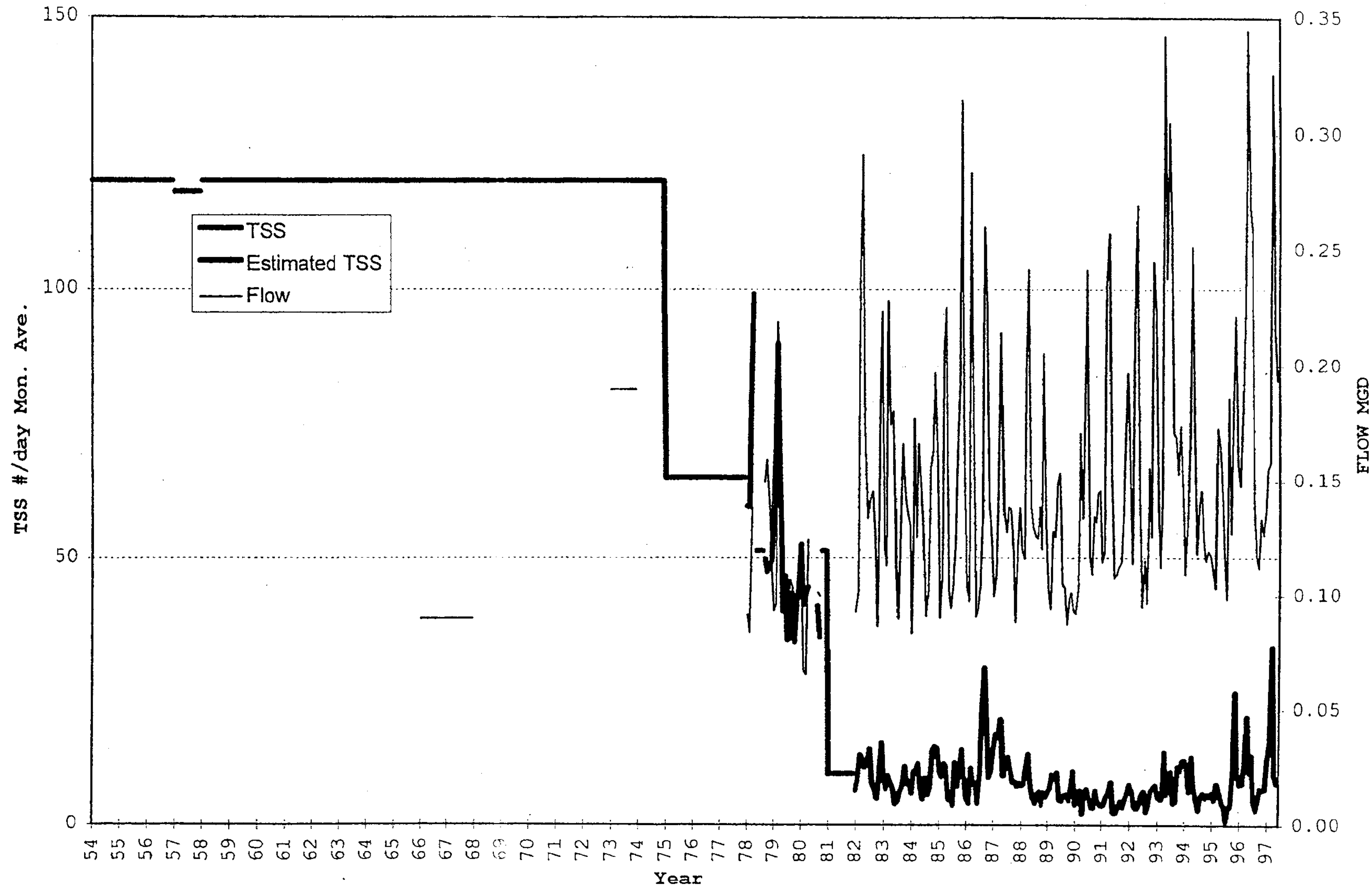


Figure A-30: DEPERE POTW

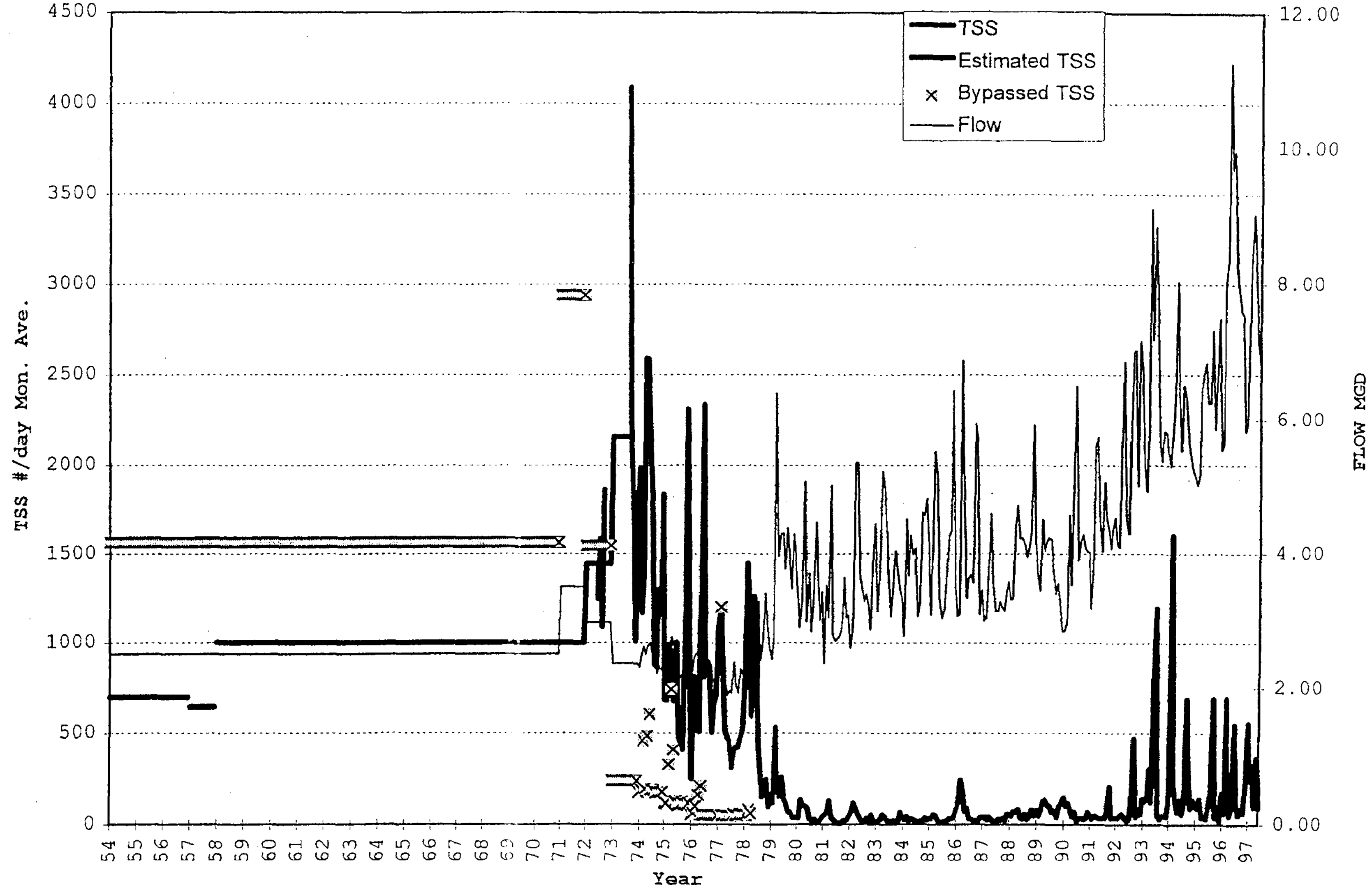
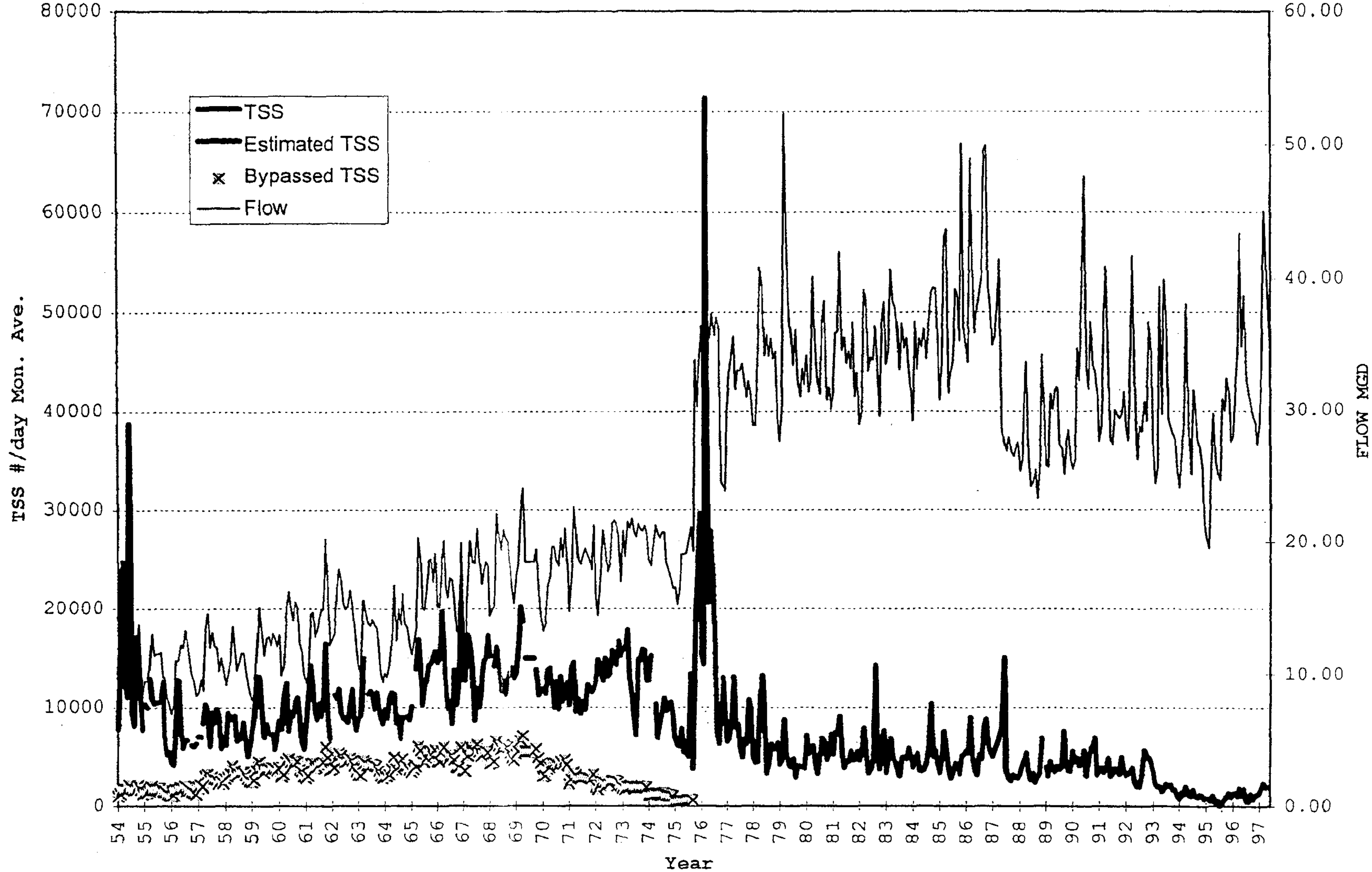


Figure A-31: GREEN BAY METRO POTW



Appendix B

Production Information for Pulp and Paper Mills

In this appendix are tables and plots of production data for each facility that had PCB release projections calculated. Not all data available is shown here. Each mill was evaluated for the most relevant type of production data to calculate discharges. In addition, the data for each mill was evaluated for the most complete data history that occurred.

Figures B-1 to B-13 show production data from up to three sources along with the best estimate used in the calculations. Data sources used included DNR data files, the Lockwood and Post directory of pulp and paper mills, and production data supplied by the mill, if available. DNR data files consists of information from two sources. First, production was determined at mills during the cooperative mill surveys which occurred up to 1967. Second, some production data were available from WPDES permit applications.

Some data were obtained by the Department from responses to interrogatories placed by the U.S. Fish and Wildlife Service (the 104e requests). The Department was granted permission to use this information by a few mills. Any data released to the Department as Confidential Business Information (CBI) under 43 C.F.R. Part 2 may have been used in calculations but is redacted from this report. This CBI is not releasable under the Freedom of Information Act. The Department agreed to this restriction to obtain the CBI production data in those cases. Where production data was obtained from Department files or other public sources, the data is shown in Table B-1 and the figures.

Table B-1	Production Estimates for Mills					
	KC Neenah	PH	American	US Paper	Wisconsin	Riverside
	Badger	Glatfelter	Tissue	Menasha	Tissue	
	Globe					
	Rag +	Deink+	Cellulose	Chip +	Deink +	Pulp +
	Cellulose	Paper	+ Tissue	Liner	Tissue	Paper
Year	T/day	T/day	T/day	T/day	T/day	T/day
1954	133	178	136	172	45	121
1955	143	182	179	201	41	125
1956	149	212	178	188	53	138
1957	146	236	176	202	59	138
1958	143	258	167	192	49	143
1959	150	260	158	201	63	150
1960	142	259	163	198	66	132
1961	152	281	167	217	66	132
1962	138	273	185	182	66	132
1963	160	296	161	189	70	125
1964	145	301	175	209	70	120
1965	137	338	189	209	129	117
1966	123	386	153	228	129	119
1967	115	391	190	175	129	118
1968	120	420	200	175	151	118
1969	125	429	205	193	161	120
1970	125	380	205	194	161	120
1971	125	410	205	205	172	122
1972	125	432	205	221	172	122
1973	128	443	205	215	185	122
1974	128	565	205	210	185	122
1975	140	543	210	205	185	122
1976	132	557	225	200	185	122
1977	132	557	215	192	185	122
1978	137	575	215	184	185	122
1979	142	576	215	176	185	122
1980	142	577	215	168	335	143
1981	142	575	215	160	360	143
1982	162	575	215	152	360	143
1983	162	575	215	144	360	143
1984	162	575	215	137	360	143
1985	162	575	215	128	360	143
1986	182	620	215	128	522	143
1987	198	616	204	145	545	143
1988	182	630	215	148	530	143
1989	197	630	215	164	530	143
1990	197	630	215	199	530	143
1991	197	650	215	250	530	136
1992	197	650	215	283	530	136
1993	197	650	215	288	530	136
1994	197	650	215	308	530	136
1995	197	650	215	318	530	136
1996	197	650	215	334	530	136
1997	197	650	215	334	530	136

Appleton Coated Mill	Appleton Locks Mill	US Paper DePere	Ft James West Mill	Procter & Gamble	Green Bay Packaging	FT James East Mill
PCB Based NCR Paper	Pulp + Paper	Board	Deink+ Tissue	Pulp + Tissue	Corrugated	Tissue
T/day	T/day	T/day	T/day	T/day	T/day	T/day
1	316	24	564	724	128	230
9	314	24	586	836	152	240
13	324	24	615	830	165	290
14	324	24	517	800	163	350
19	309	24	519	652	159	375
28	399	29	548	593	174	361
30	387	29	608	375	201	354
38	309	29	627	818	215	361
49	320	29	646	1298	222	377
58	350	37	660	814	227	415
65	310	39	665	865	232	354
79	315	46	895	922	250	449
93	479	44	883	1533	258	437
98	468	47	975	2396	243	400
118	375	47	1029	1198	247	430
155	375	47	1051	1198	268	430
148	575	47	1241	1198	265	400
28	600	47	1283	1198	269	400
0	600	47	1384	1198	283	450
0	600	50	1495	1198	284	400
0	600	50	1524	1198	259	400
0	600	55	1557	1198	245	400
0	400	61	1590	1198	254	400
0	400	61	1618	1198	260	400
0	400	65	1636	1198	278	400
0	400	67	1594	1198	268	400
0	400	67	1623	1198	275	400
0	635	79	1629	1198	247	400
0	635	84	1612	1198	211	410
0	645	84	1637	780	294	410
0	650	92	1749	780	310	410
0	650	92	1976	780	290	410
0	700	98	1978	780	346	430
0	837	98	1963	893	365	353
0	700	98	1954	780	391	470
0	730	98	1967	780	343	470
0	730	98	1967	780	410	470
0	730	100	1967	780	345	470
0	730	100	1967	780	425	470
0	730	100	1967	780	490	470
0	730	100	1967	780	518	470
0	730	100	1967	780	564	470
0	730	100	1967	780	536	470
0	730	100	1967	780	550	470

Figure B-1: KIMBERLY CLARK CORPORATION - NEENAH/BADGER GLOBE

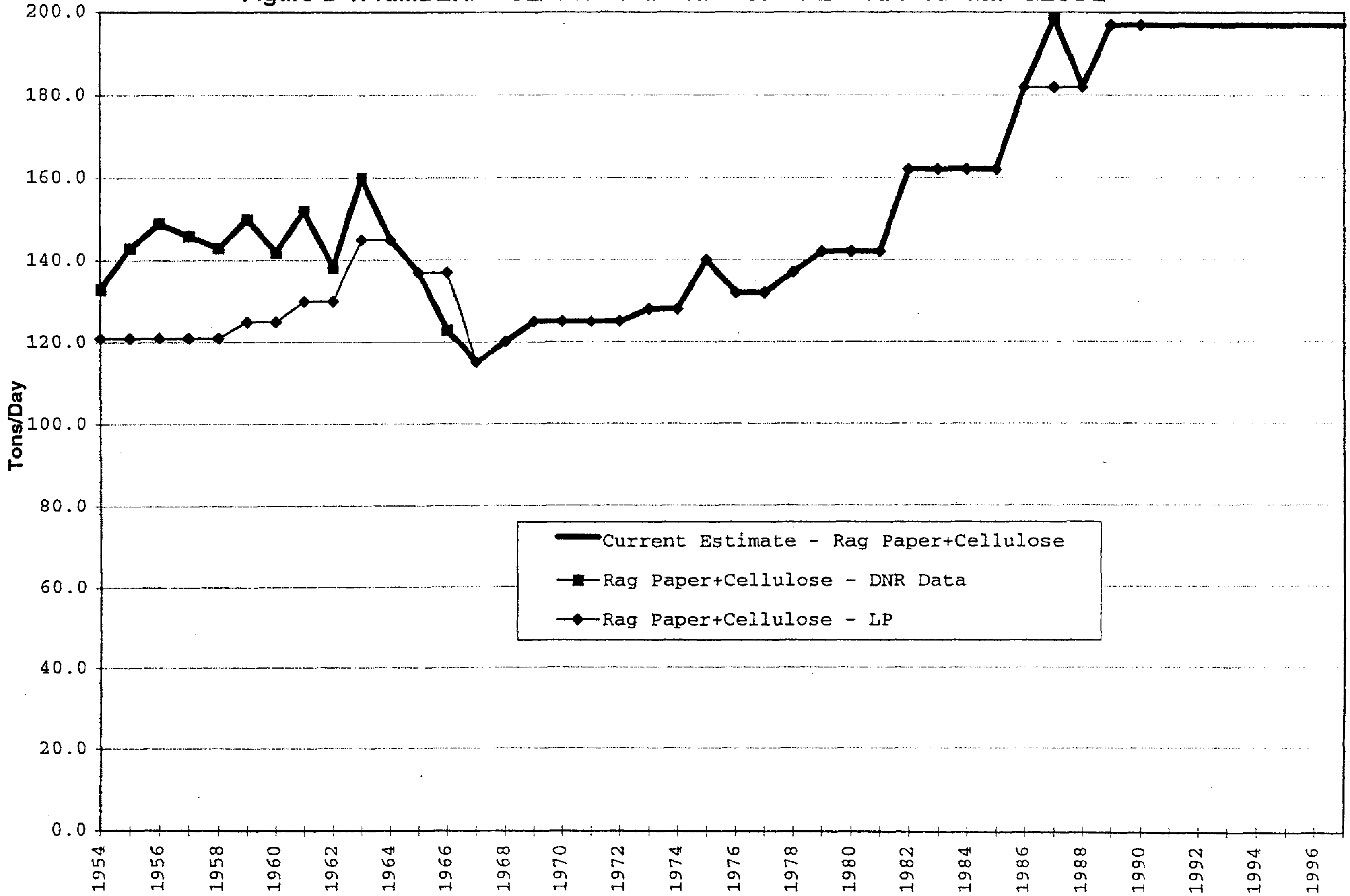


Figure B-2: PH GLATFELTER COMPANY

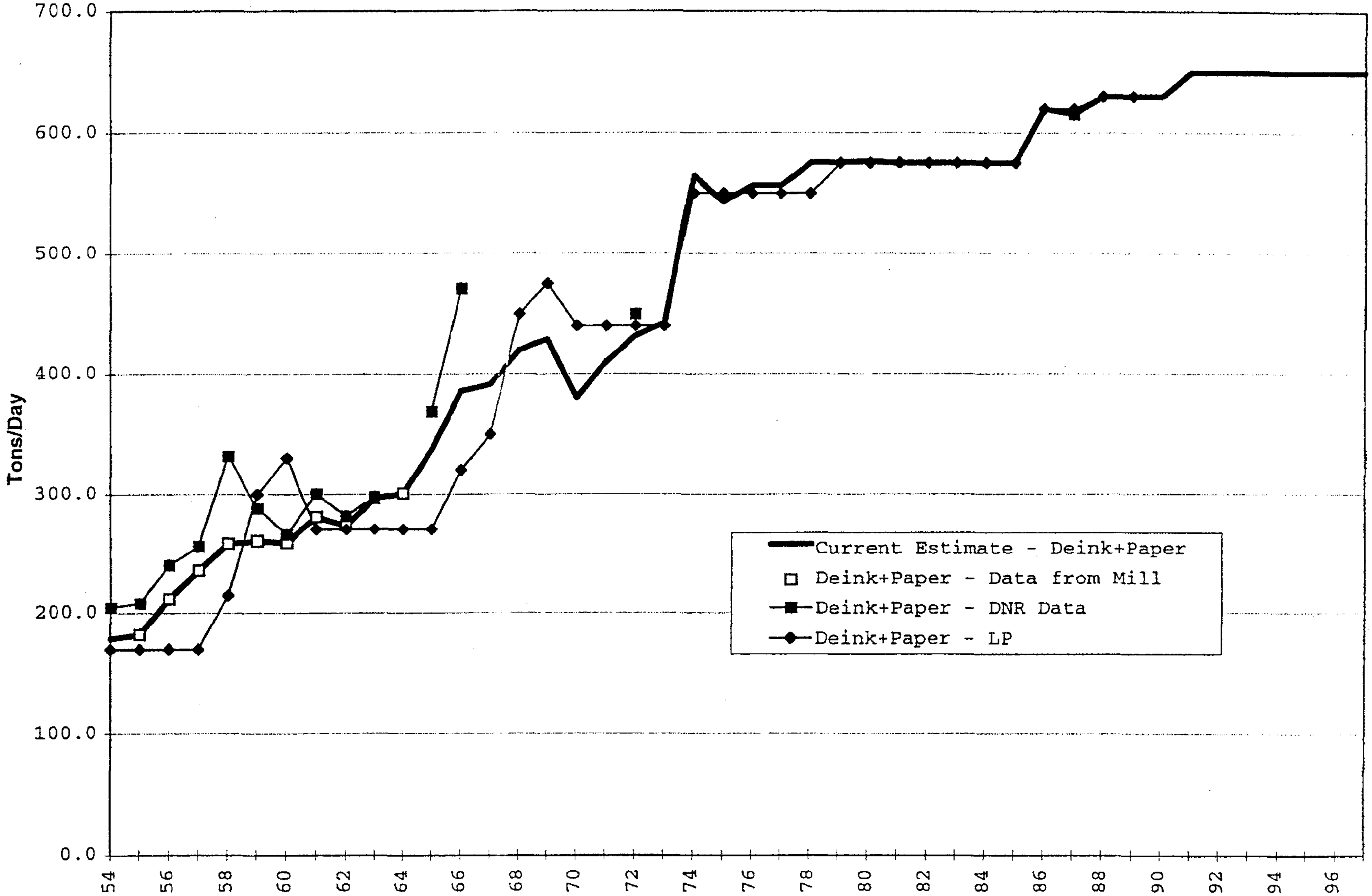


Figure B-3: AMERICAN TISSUE MILLS

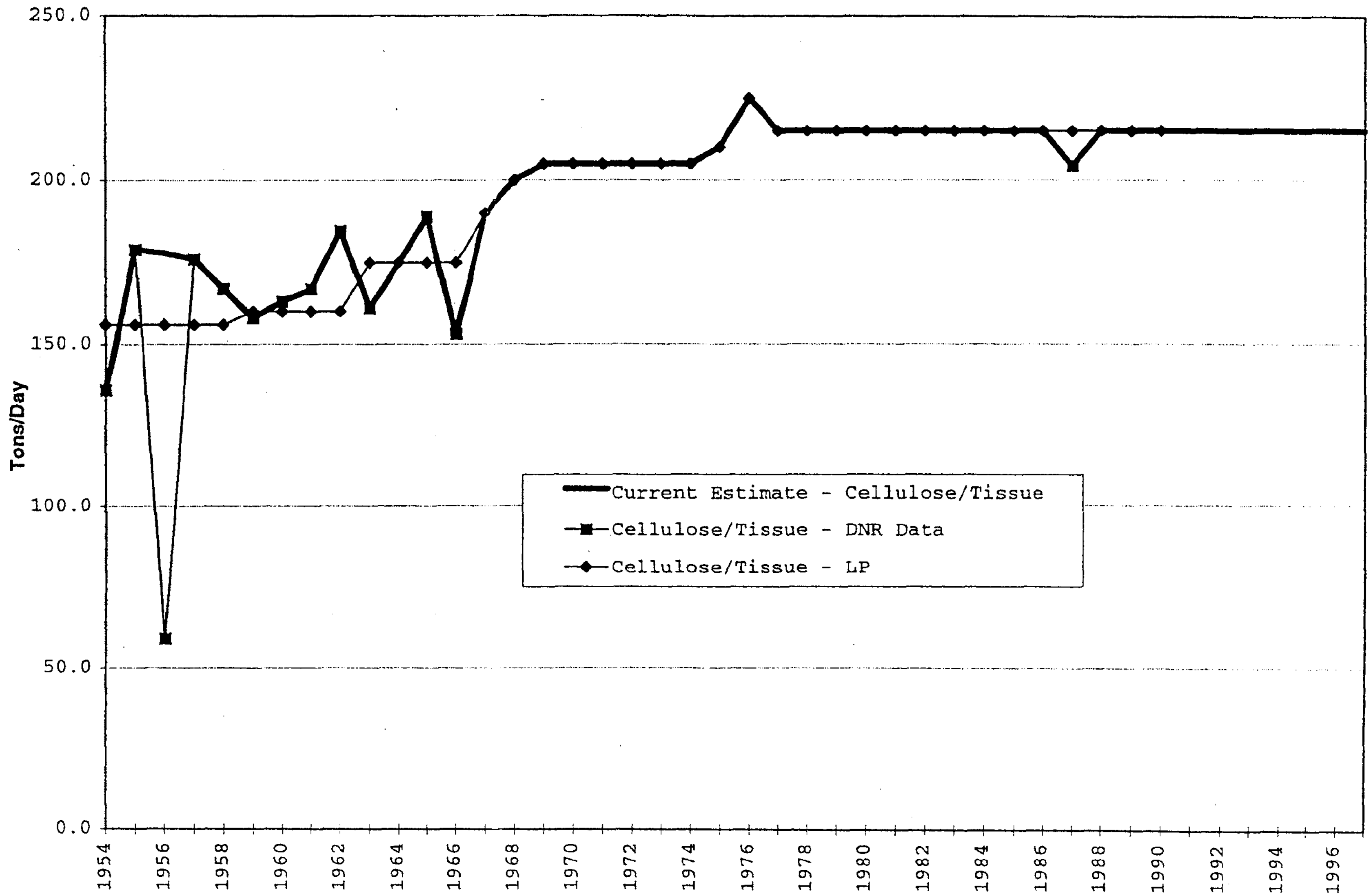


Figure B-4: US PAPER MILLS CORPORATION - MENASHA DIVISION

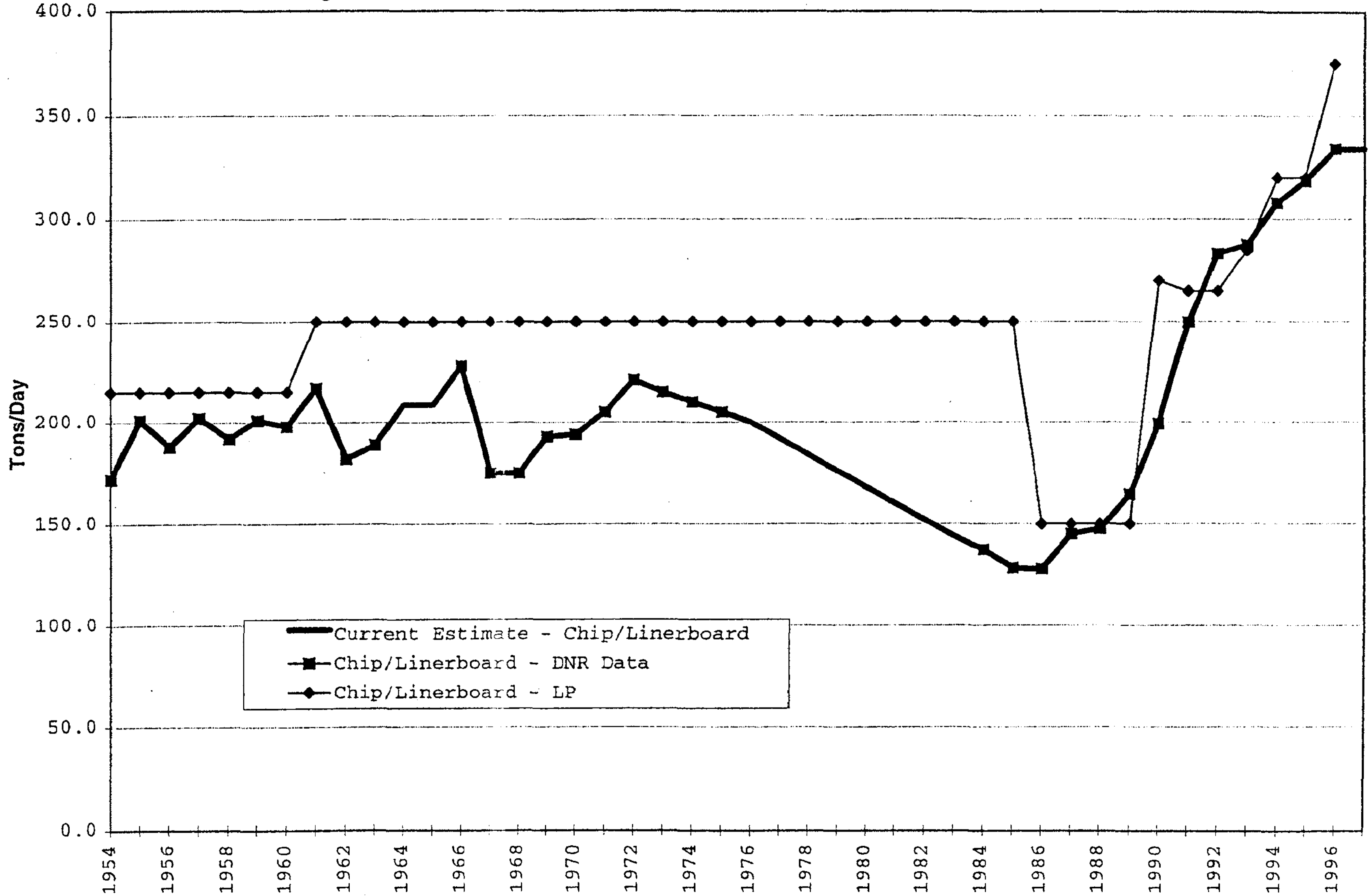


Figure B-5: WISCONSIN TISSUE MILLS

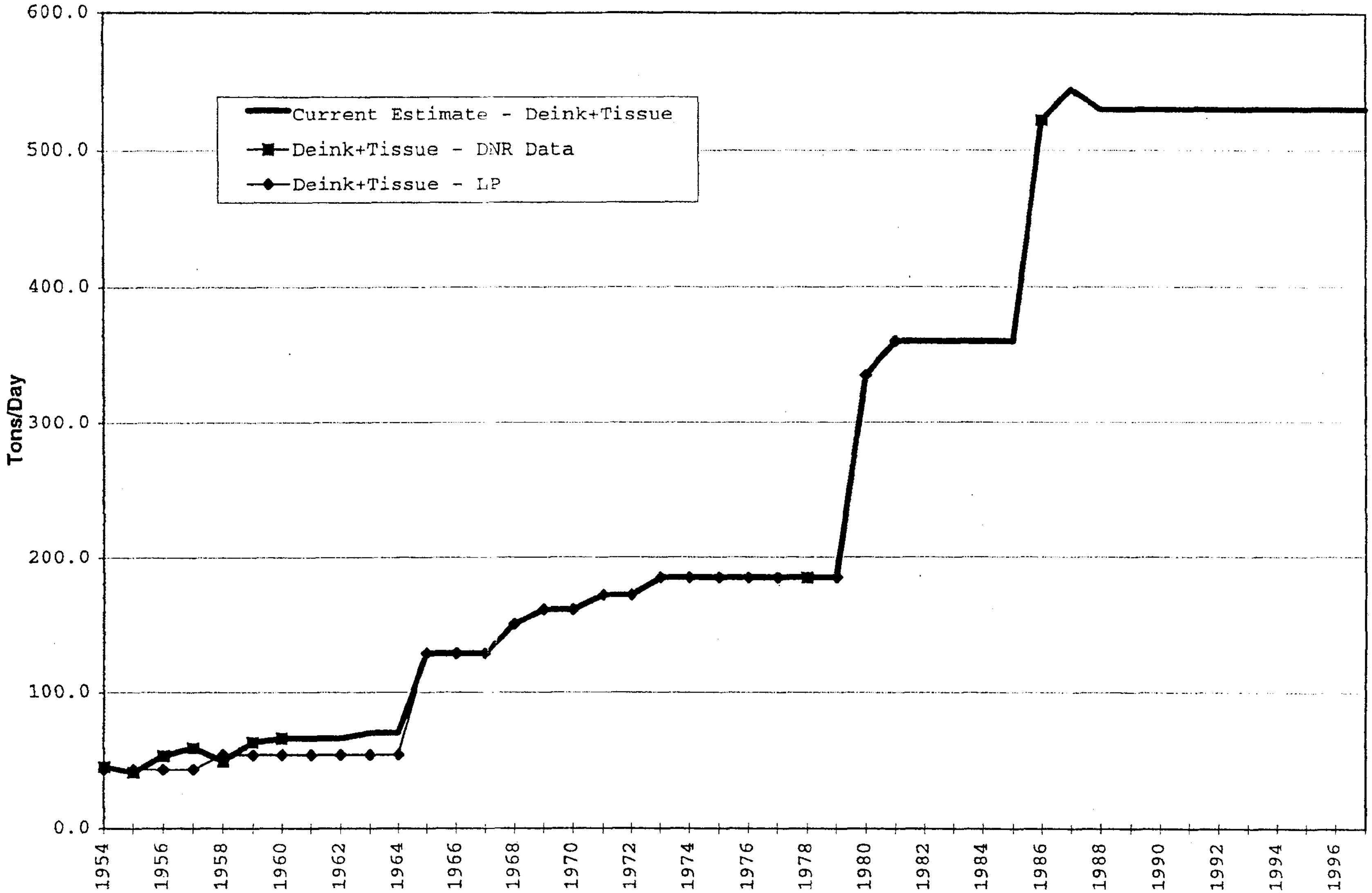


Figure B-6: RIVERSIDE PAPER CORPORATION - KERWIN DIVISION

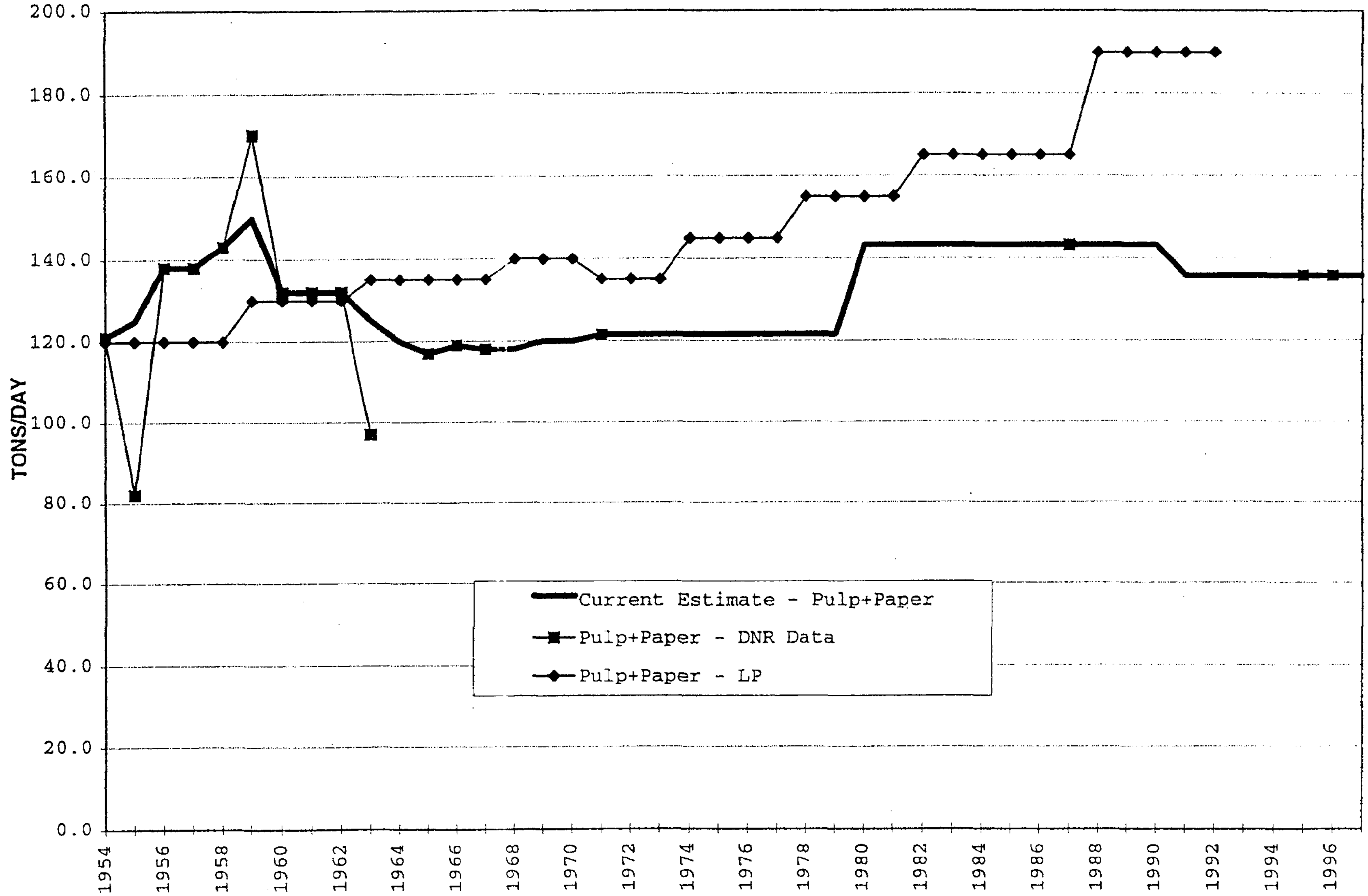


Figure B-7: APPLETON PAPERS-COATING MILL

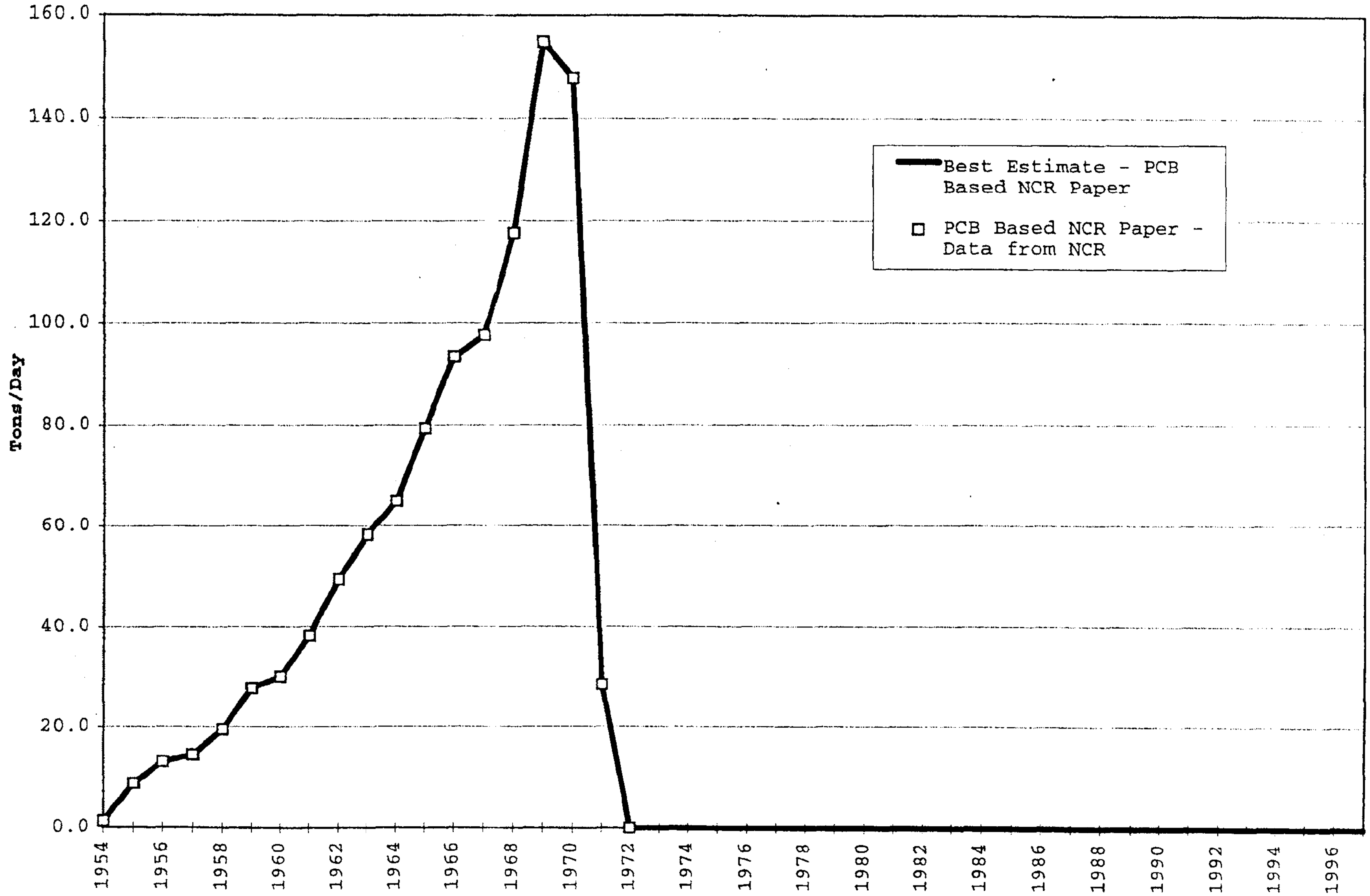


Figure B-8: APPLETON PAPERS - LOCKS MILL

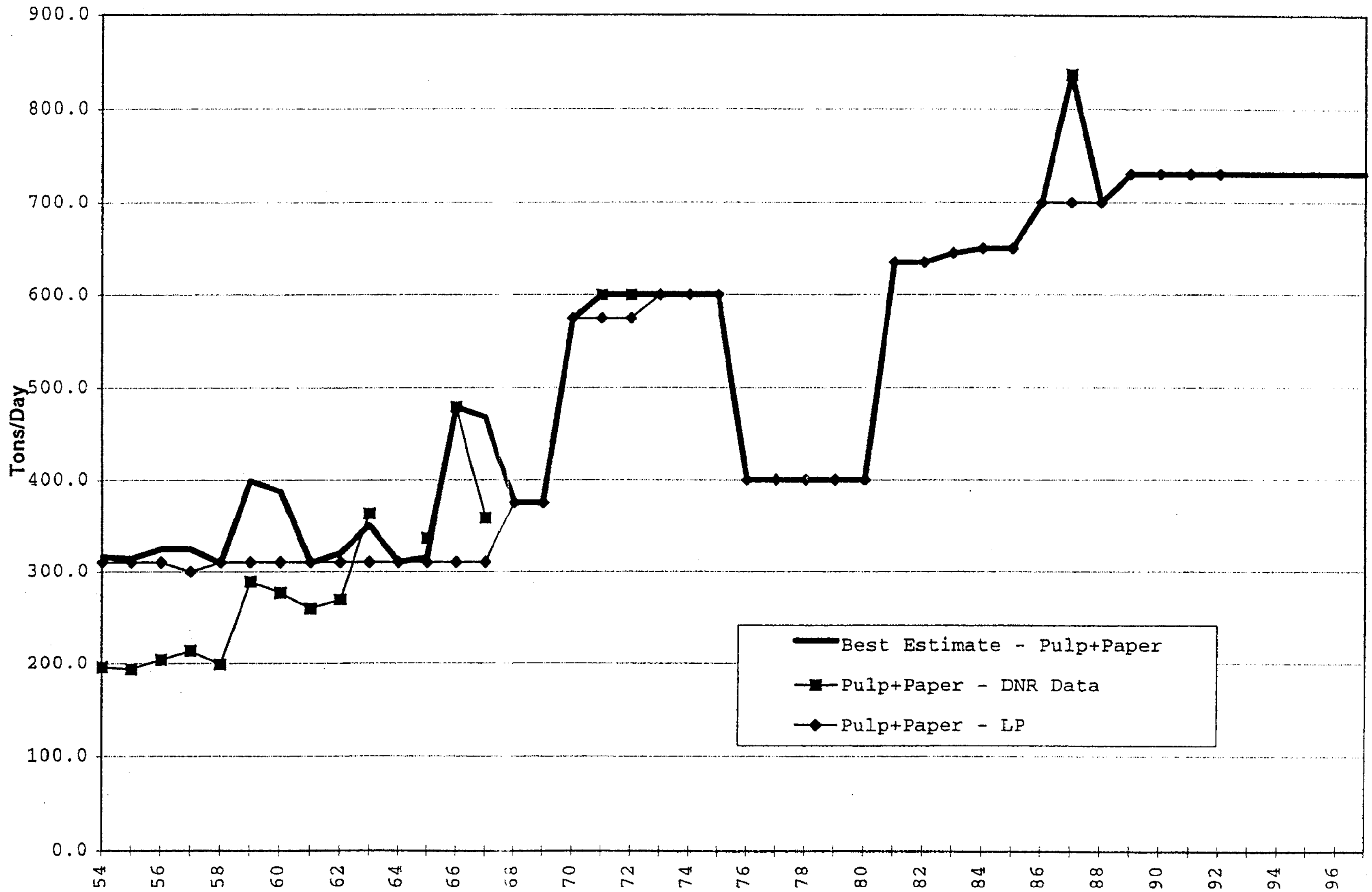


Figure B-9: US PAPER MILLS CORPORATION - DEPERE DIVISION

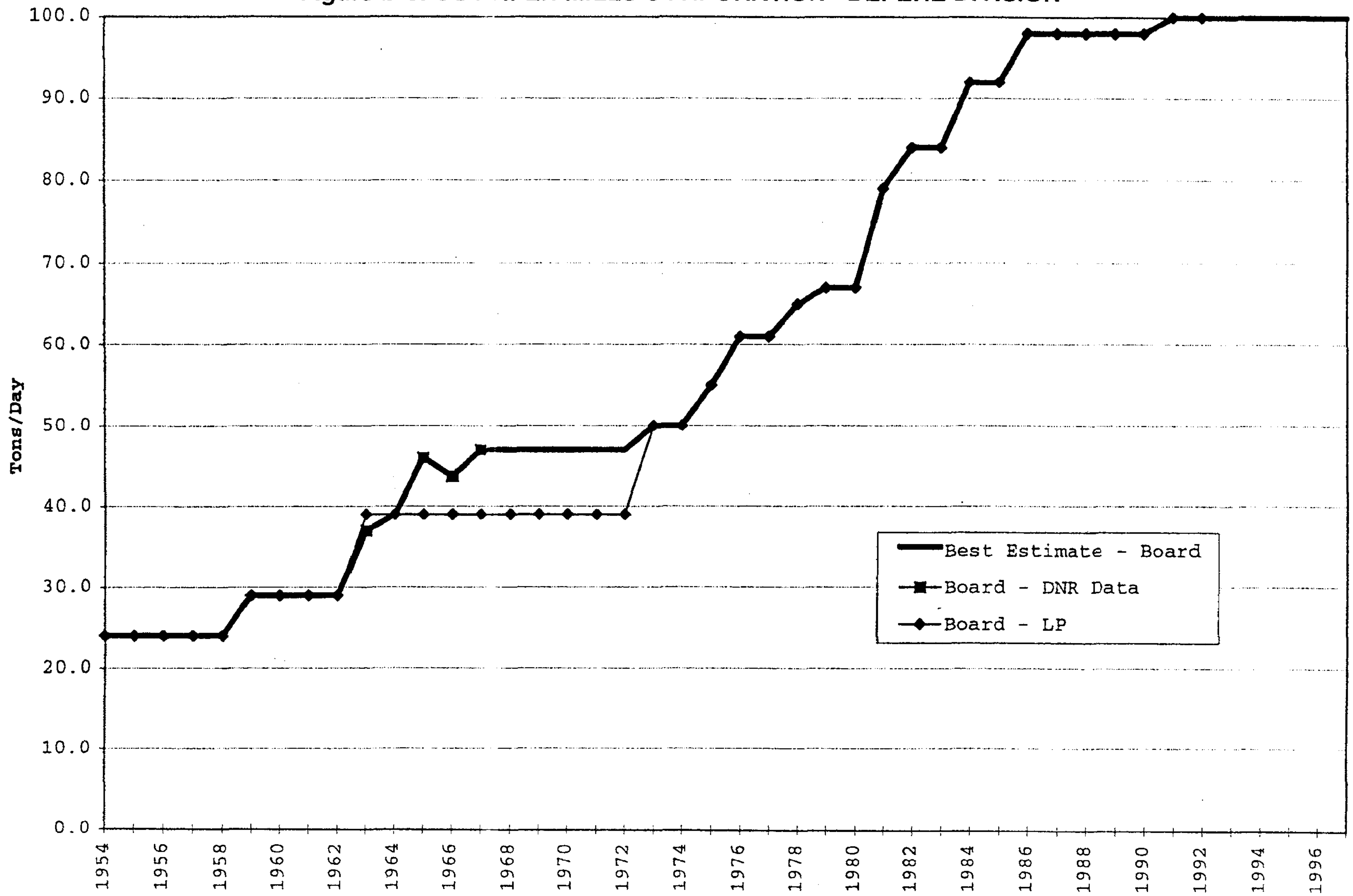


Figure B-10: FT JAMES - GREEN BAY WEST MILL

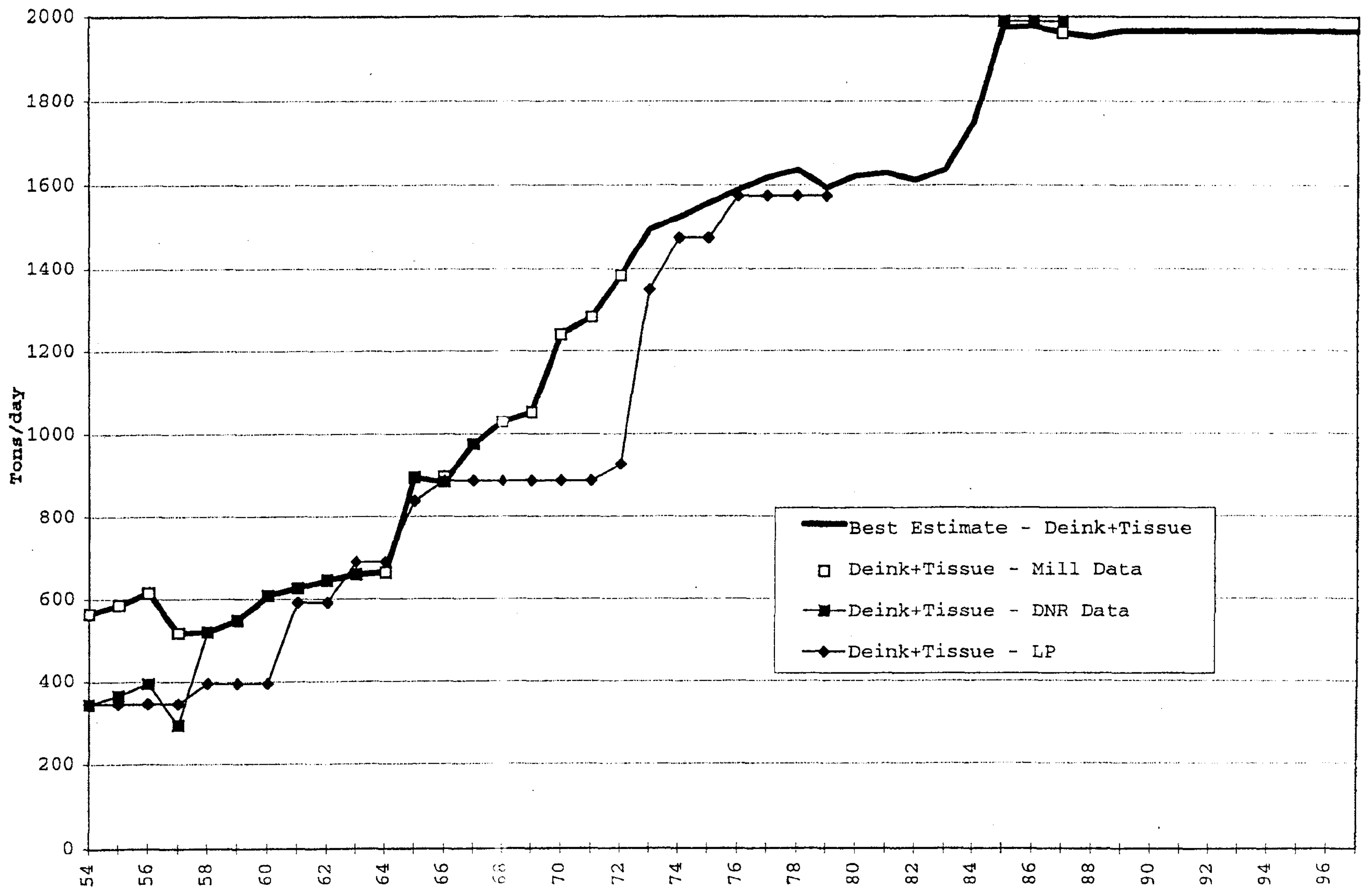


Figure B-11: PROCTER & GAMBLE PAPER PRODUCTS COMPANY

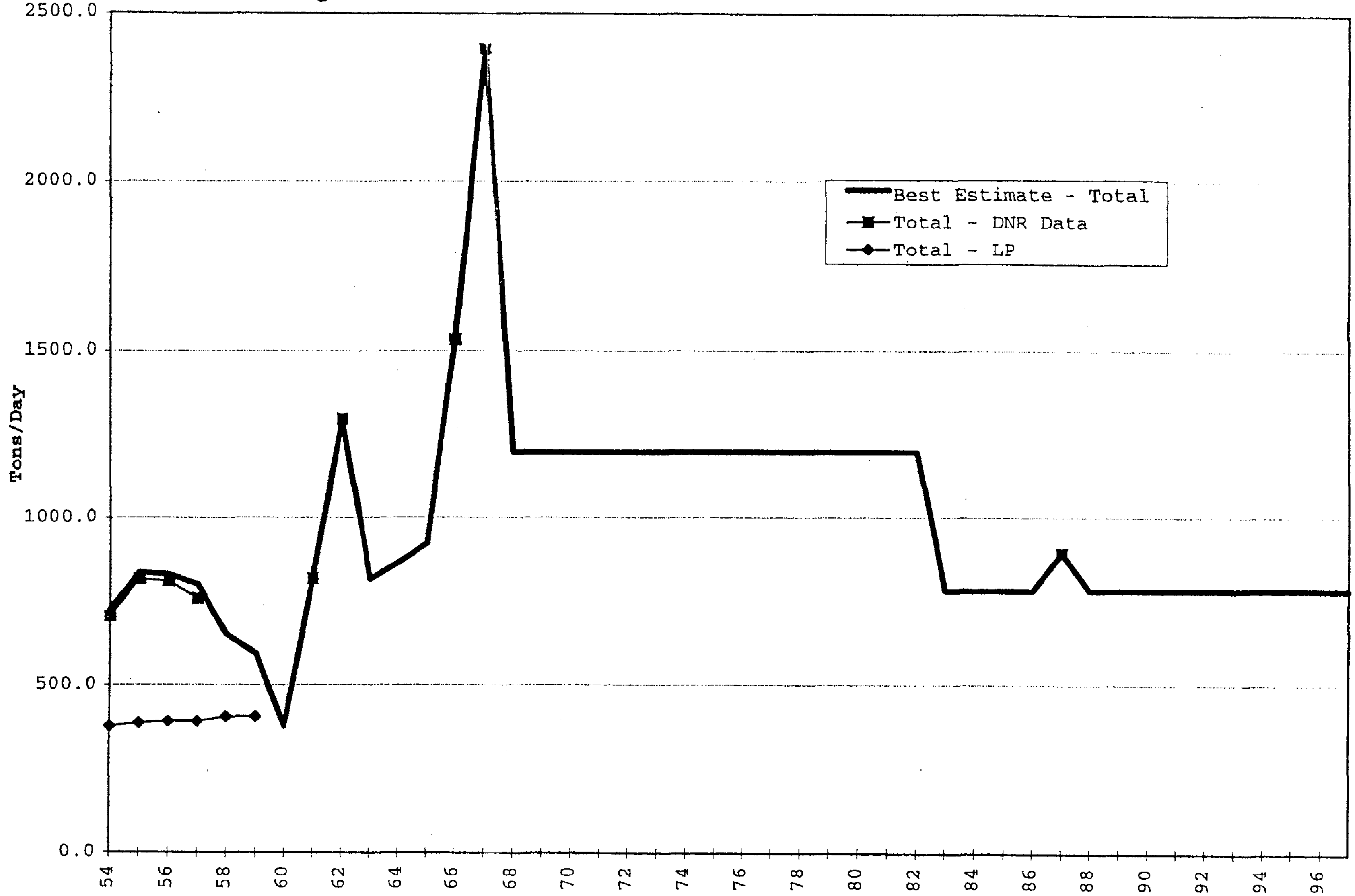


Figure B-12: GREEN BAY PACKAGING INCORPORATED

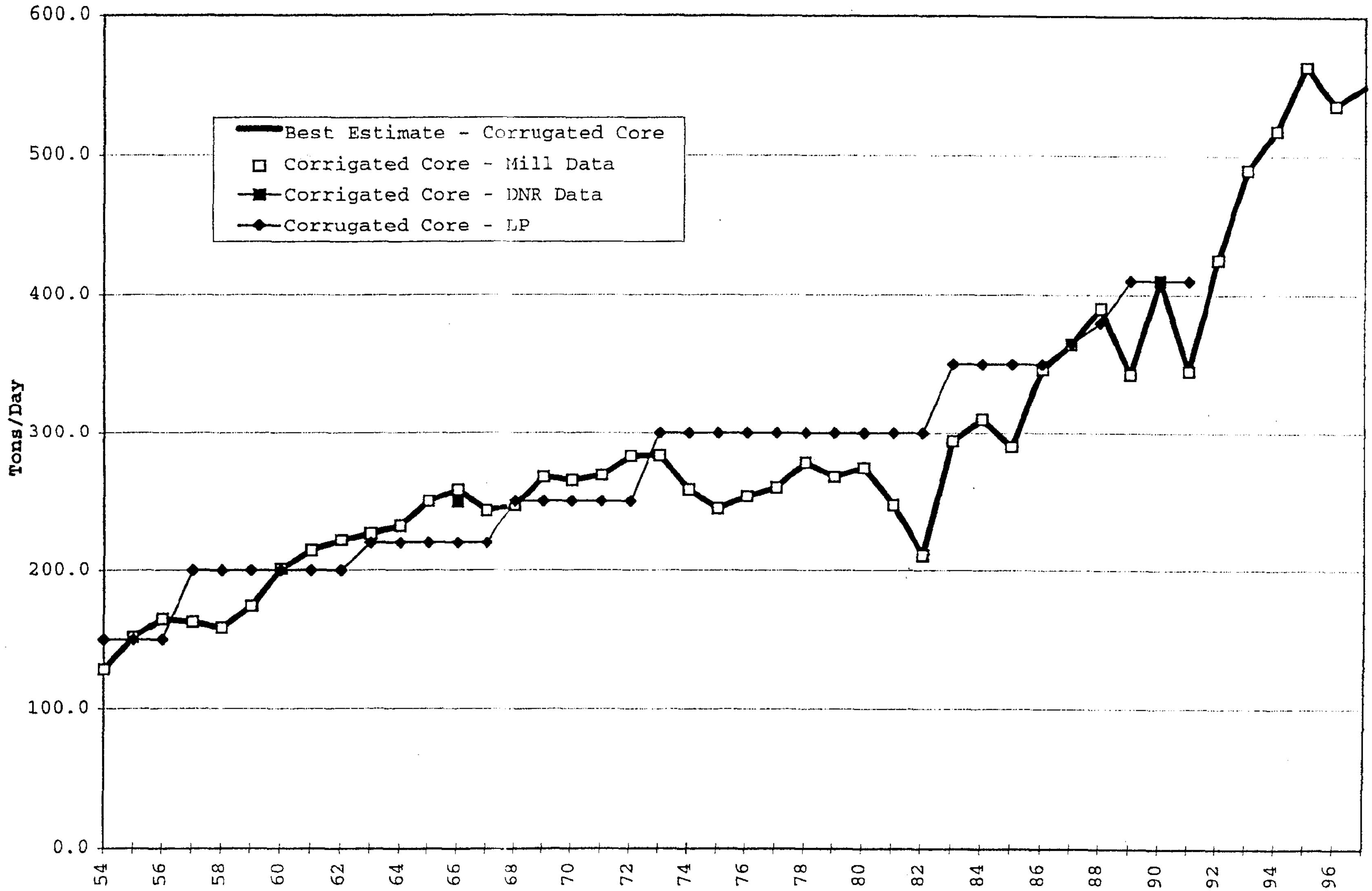
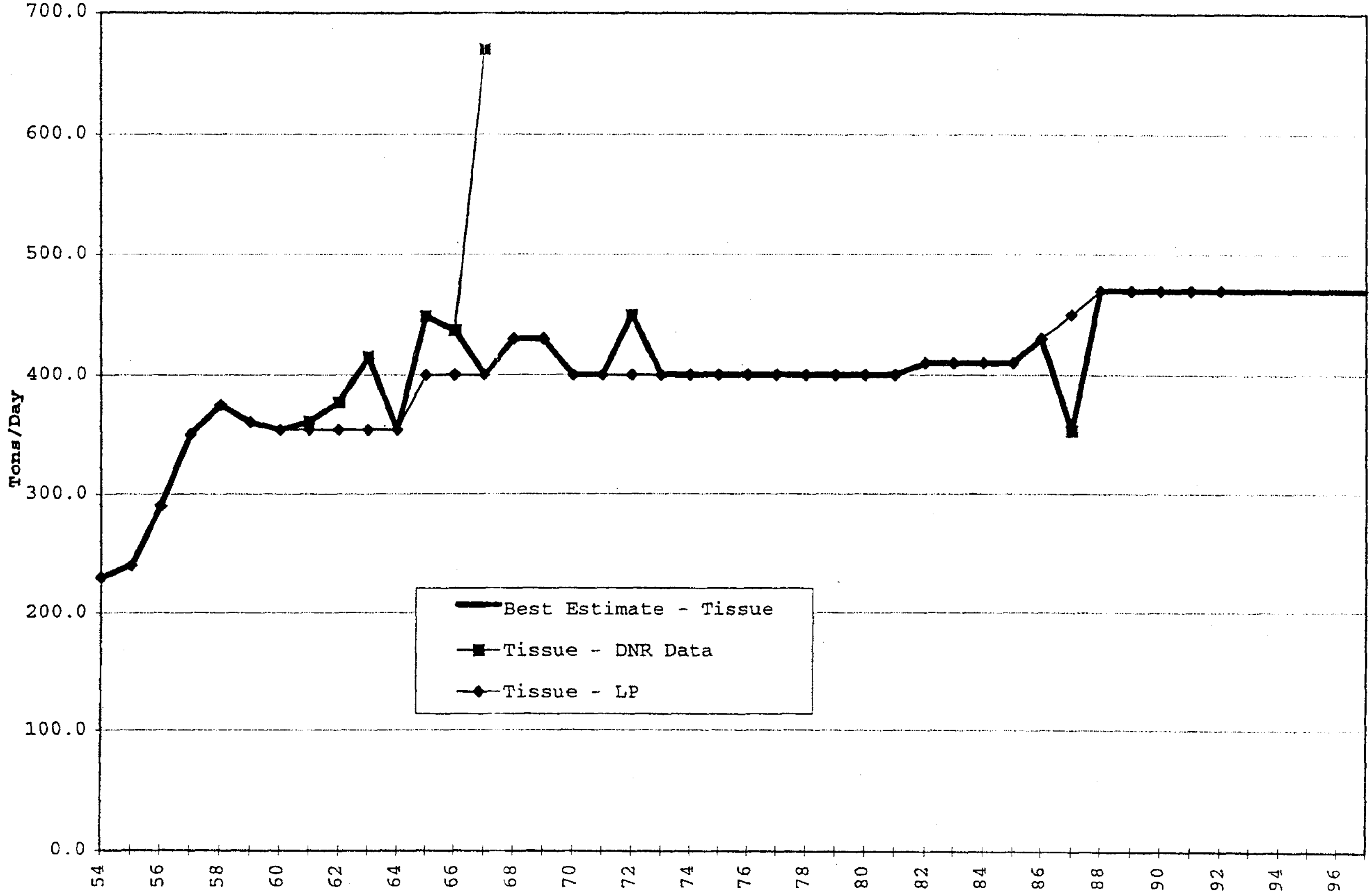


Figure B-13: FT JAMES - GREEN BAY EAST MILL



Appendix C

Effluent PCB Data from the Wisconsin State Laboratory of Hygiene

The primary source of PCB effluent data for point sources on the Fox River came from laboratory notebooks kept by the Wisconsin State Laboratory of Hygiene (SLoH). These books had records of essentially all PCB sample analyses performed during the 1970s and provided the best record of this data. The enclosed table shows the lab book used, the date associated with the sample, the type of sample, effluent flow if known, PCB concentration normally in ug/l and the Aroclor of the PCB result if recorded. Nearly 700 samples are documented in these books and represents a significant information base at a point in time just after the heaviest usage of PCB from NCR Paper occurred.

Other sources of PCB data exist, particularly among some of the paper mills that discharged high concentrations of PCB. This data was consulted on a qualitative basis but was not used quantitatively for the most part. There are several reasons for not using those data in a quantitative manner. First, the information available from these sources is incomplete. Second, most of the data reported pertain to the PCB content of paper products and not the wastewater effluents that are the subject of this report. Finally, an interlab comparison of data revealed that statistically significant differences existed between various labs performing PCB analyses during the 1970s. In one interlab comparison involving the SLoH, WARF, a paper mill lab, and a private lab, a consistent factor of 2.7 difference was noted between the SLoH and the WARF lab, with the SLoH giving consistently higher results. The paper mill lab averaged results similar to the WARF lab but with considerably more variability. The private lab had still more variability in results.

Many reasons can be postulated for the differences between labs reporting PCB results during the early to mid-1970s. Since lab procedures were still being developed, extraction methods and particularly cleanup of samples in messy media was tricky. By 1975, the SLoH had considerable experience in extracting PCB samples from sediments, fish tissue and paper mill and POTW effluents. It is doubtful if any other lab in the country had as much experience in PCB sample extraction and cleanup from these types of media. In various interlab tests involving the SLoH over the years, they have consistently performed well. For these reasons, it was determined that the SLoH data set would be the primary basis for the discharge hindcasts presented in this report. It should be noted that these data are useable only to hindcast discharges of PCBs resulting from the recycle of WASTEPAPER/SECONDARY FIBER as defined in Section 7.0.

State Laboratory of Hygiene data were used for these calculations with one significant exception. PCB concentrations in paper products were most available from paper mill labs. This data was used to develop an approximation of the rate of decay of PCB in paper fiber during the late 1970s and 1980s. It should be noted that the rate of decay was the primary result calculated using mill reported data and that actual paper products PCB concentrations were not used in the calculation of PCB releases.

Table C-1: Effluent PCB Data From the State Lab of Hygiene

PCB DATA TAKEN FROM OLD LAB BOOKS:	Beh=Letter from Bob Behrens to Leon Aciertb
1="OLD FISH" BOOK - SLOH (2/14/72-11/4/75)	WT=Wisconsin Tissue Data
2="SDWA ET. AL." BOOK -SLOH (11/4/75-6/24/81)	RIV=Riverside Data
3="EPA-FOX RIVER" (11/24/76-8/10/77)	IPC=Institute of Paper chemistry
4="PCB Sampling Winn. County" (2/6/75-7/12/78)	FTH=Fort Howard Samples
5="PCB Sampling Outagamie County" (10/15/74-3/3/76)	USP=US Paper
6="PCB Sampling Brown County" (7/8/74-6/26/78)	N101=NR 101 discharge files.
7="Pesticide & Toxic Metals" (1983)	
8="Toxic Organic Substances Project" (3/29/78-12/15/78)	

Neenah-Menasha POTW-------------------------||

book	date	type	flow	conc	archlor
1	3/28/72	raw		8.20	1248
1	3/28/72	final		3.30	1248
1	2/24/73	final	12.90	2.10	1248
1	9/8/73	final	15.00	2.10	1248
1	11/4/74	final	13.97	0.16	1248
4	10/16/75	final	15.73	0.16	1248
2+4	1/20/76	sludge		4.3ppmwet?	
2+4	1/20/76	final		0.25	1242
3	12/1/76	effluent		<.1	
3	12/1/76	influent		6.60	
3	12/1/76	final		0.10	1242
3	2/28/77	final		<.2	
3	2/28/77	raw	*	<.2	
3	7/20/77	final		<.2	
8	9/21/78	final		nd	
8	9/21/78	raw		nd	

GC/MW (Menasha SD 4 West)---------------||

book	date	type	flow	conc	archlor
1	3/8/73	final	0.83	0.40	1254
3	12/13/76	final		<.1	
3	12/14/76	final		<.2	
3	12/14/76	final		<.2	
3	3/9/77	primary		0.37	
3	3/9/77	final		<.2	
3	3/9/77	raw		1.00	1248+1254
8	6/28/78	raw		<.2	
8	6/28/78	final		nd	

Town of Menasha East-----------------------||

1	9/27/73	final	0.83	<.05	

Fox River Sediment-----------------------------------||

book	date	type	flow	conc	archlor
1	7/10/75	STP outfall where?		72ppm	
2	7/29/76	sed llbdm		27ppmd	1242
2	7/29/76	sed llbdm		10.1ppm	1242
2	7/29/76	sed llbdm		10.5ppm	1242
2	7/29/76	sed llbdm		1.8ppm	1242
2	7/29/76	sed llbdm		1.3ppm	1242
2	7/29/76	sed llbdm		1.1ppm	1242
2	7/29/76	sed llbdm		1.2ppm	1242
2	7/29/76	sed llbdm		6.9ppm	1242
2	7/29/76	sed llbdm		7.6ppm	1242
2	7/29/76	sed llbdm		6.6ppm	1242
2	8/10/76	sed sta 49		7.4ppm	1242
2	8/10/76	sed sta 49		7.7ppm	1242
2	8/10/76	sed sta 56		8ppmdr	1242
2	8/10/76	sed sta 60		10.7ppm	1242
2	8/10/76	sed sta 52		7.5ppm	1242
2	8/10/76	sed sta 63		2.4ppm	1242
3	11/24/76	sed App Yacht Clu		8.2ppb?	1242
3	11/24/76	sed LLBDM		5.5ppm	
3	12/1/76	sed LLBDM		<.1	
3	2/15/77	Sta 10 Green Bay		7.2	
3	2/15/77	Sta 14 GR Bay		2.6	
3	2/15/77	Sta 12 Gr Bay		4.7	
3	2/15/77	Sta 6a Gr Bay		18.1	
3	2/15/77	Sta 5 Gr Bay		0.5	1242
3	2/15/77	Sta 5a Gr Bay		<.05	
3	2/15/77	Sta 17 Gr Bay		<.05	
3	5/26/77	Menasha Channel		<.5	
3	5/26/77	LLBDM creek wes		61.0	
3	5/26/77	Nee Chan below b		1.4	1242
3	5/26/77	llbdm cnwrr		1.3	1242+48
3	5/26/77	llbdm outlet		21.0	
3	5/26/77	below cons		1.2	1242+48
3	5/26/77	above kim dam		0.9	
3	5/26/77	cnwrr at depere		18.3	
3	5/26/77	gb coast guard sta		2.1	
3	5/26/77	channel s of LT pt		5.6	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

3	12/13/76	final		<.1	
8	5/18/78	raw		nd	
8	5/18/78	final		<.2	
7	5/17/83	final		<.5	
Appleton POTW---------------------------------------||					
book	date	type	flow	conc	archlor
1	4/28/72	raw		1.40	1248
1	4/28/72	final		0.90	1248
1	5/5/72	final		0.22	1248
Beh	2/16/73	final	13.38	0.14	
1	2/15/73	final	13.98	0.26	1242&1254
1	8/24/73	final	13.80	0.07	
1	5/30/74	final		0.12	1242
3	12/13/76	pri bypass		23.00	
3	12/14/76	final		<.2	
3	3/3/77	raw		1.40	1242
3	3/3/77	primary		0.40	1242
3	3/3/77	final		0.60	1242
3	7/22/77	raw		1.30	1242
3	7/22/77	final		<.2	
8	9/25/78	final		nd	
8	9/25/78	raw		0.20	
7	4/4/83	final		<.5	
Kimberly POTW---------------------------------------||					
book	date	type	flow	conc	archlor
1	2/24/73	final	0.63	0.15	1254
1	9/19/73	final		0.35	1254
3	12/13/76	final		<.2	
LIttle Chute POTW---------------------------------||					
book	date	type	flow	conc	archlor
1	3/8/73	final	1.34	<.05	
1	9/20/73	final	0.50	la	
1	10/15/73	final	0.77	<.05	
3	12/13/76	final		<.2	
KAUKAUNA POTW-----------------------------------||					
book	date	type	flow	conc	archlor
1	4/28/72	raw		0.65	1254
1	4/28/72	final		<.05	1254
1	2/16/73	final	2.47	0.11	1254
1	10/3/73	final	1.34	0.09	1254
5	10/15/74	final		0.10	
1	11/4/74	final	1.25	<.1	
3	12/14/76	final		<.2	
3	3/3/77	raw		<.2	

3	5/26/77	channel ne of LT p		0.0	
3	5/26/77	Opposite PT east		0.1	1242+48
3	5/26/77	across from LT pt		11.0	
3	5/26/77	mouth below stp		7.5	
3	6/6/77	above lr dam		5.0	
3	6/6/77	below thil mill		4.8	
3	6/6/77	abv rap croche		7.6	1242
3	6/23/77	bel app dam		3.6	
3	6/23/77	abv depere dam		0.2	
3	7/22/77	little chute		5.1	
3	7/22/77	abv lower app dam		9.0	
3	7/27/77	mouth east riv		13.0	
3	7/27/77	across ft how		1.0	
8	8/10/78	bel berg 1/4 mile		18.0	
8	8/10/78	bel berg 1/4 mile d		14.5	
		*=interference			
P H GLATFELTER COMPANY-----------------||					
book	date	type	flow	conc	archlor
1	5/2/74	clar eff	4.14	18.5	1242
1+4	2/6/75	final	3.88	50.0	1242
1	2/17/75	pulp waste water		35.0	1242
1+4	4/22/75	final/clar		18.0	1242
1+4	5/20/75	final	*	4.5	
1+4	6/30/75	final/cla	*	12.0	
4	6/30/75	final		11.0	
1+4	7/18/75	final/clar		27.0	1242
1	7/18/75	final/clar		28.0	
4	7/18/75	f		23.0	1242
1	7/22/75	final/clar		4.4	
1+4	8/15/75	final/cla	*	12.0	
4	8/15/75	f		7.7	
1+4	9/26/75	final		62.0	1242
4	9/26/75	f		48.0	1242
2+4	10/7/75	final		9.9	1242
4	10/7/75	f		15.0	1242
2+4	11/26/75	final		75.0	1242
4	11/26/75	f		43.0	1242
2+4	12/22/75	raw		125.0	1242
2	12/22/75	raw		109.4	
2+4	12/22/75	final		52.0	1242
2	12/22/75	final	ave?	44.0	
4	12/22/75	r		58.0	1242
4	12/22/75	f		38.0	1242
2+4	1/9/76	final		75.0	
2+4	1/9/76	raw		54.0	
4	1/9/76	f		44.0	
4	1/9/76	r		54.0	
4	1/9/76	r		22.0	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

3	3/3/77	final		<.2	
3	7/22/77	final		<.2	
8	9/28/78	raw		nd	
8	9/28/78	final		nd	
HOV POTW---||					
book	date	type	flow	conc	archlor
N101	7/22/77	final		<.2	
7	4/4/83	final		<.5	
Wrightstown POTW----------------------------------||					
book	date	type	flow	conc	archlor
1	3/21/73	final	0.23	<.05	
3	12/14/76	final		0.36	1254
7	4/25/83	final		<.5	
DePere POTW--||					
book	date	type	flow	conc	archlor
1	5/17/72	raw		0.70	1254
1	5/17/72	final		1.90	1254
Beh	2/15/73	final	2.36	0.30	
1	2/19/73	final		0.31	1254
1	8/30/73	final	8.70	1.20	1254
1+6	10/15/74	final	2.38	0.50	1248
3	12/13/76	final		<.2	
3	3/8/77	final		0.60	1254
3	3/8/77	raw		0.50	
3	7/27/77	final		<.2	
8	10/4/78	final		nd	
8	10/4/78	raw		<.5	
7	5/17/83	final		<.5	
Green Bay Metro SD------------------------------||					
book	date	type	flow	conc	archlor
1	5/17/72	raw		1.10	
1	5/17/72	final		0.10	1254
1	2/21/73	final	18.38	0.44	1254
1	8/11/73	final	20.88	0.28	1254
4	9/18/74	final		0.10	
1	10/11/74	final		<.1	
2+6	1/23/76	ret sludge		.46ppm	1254
2+6	1/23/76	pri sludge		.44ppm	1254
2+6	1/22/76	final	35.64	0.40	1242
3	12/9/76	final		<.2	
3	3/8/77	raw		<.2	
3	3/8/77	final		<.2	
3	3/8/77	final/chlor		<.2	
3	7/28/77	final		<.3	
3	7/28/77	comb influents		<.3	

2	1/20/76	sludge		23ppm dry	
2+4	1/22/76	raw		105.0	
2	1/22/76	raw	ave?	103.0	
2+4	1/22/76	final		17.0	
2+4	1/22/76	final		16.0	
2+4	1/30/76	raw	*	<10	
2+4	1/30/76	final		19.0	
2+4	2/6/76	final		34.0	
2	2/6/76	final	ave?	43.0	
4	2/12/76	f		49.0	
2+4	2/13/76	raw		90.0	
2+4	2/13/76	final	*	36.0	
4	2/13/76	r		79.0	
2	2/26/76	lf well 1		<.1	
2	2/26/76	lf well 1a		<.1	
2	2/26/76	lf well 7		<.1	
2	2/26/76	lf well 7a		<.1	
2+4	3/11/76	final		10.0	1242
2	3/11/76	raw	*	<5	
4	3/11/76	f		14.0	1242
4	3/11/76	r	*	3.2	
4	3/11/76	r	*	7.8	
2	3/31/76	lf well 3		<.1	
2	3/31/76	lf well 3a		<.4	
4	4/21/76	r	*	8.9	
4	4/21/76	f	*	7.5	
2	5/13/76	raw		3.2	
2	5/13/76	final		la	
2	5/21/76	final		78.0	
4	5/21/76	r		92.0	
4	5/21/76	f		58.0	
2+4	5/25/76	final epa		78.0	
2	5/25/76	raw		128.0	
2+4	5/25/76	raw epa		125.0	
2+4	6/18/76	raw		165.0	
2+4	6/18/76	final		39.0	
4	6/18/76	final		34.0	
4	6/18/76	r		150.0	
4	6/18/76	f		34.0	
4	7/16/76	raw	*	27.0	
4	7/16/76	final		<.1	
2	7/20/76	final		6.0	1242
2	7/20/76	final epa		5.0	
4	7/20/76	f		5.5	1242
2	8/23/76	final	*	10.0	
2	8/23/76	raw		27.0	1242
2+4	9/20/76	raw	*	11.0	
4	9/20/76	raw		10.0	1242
4	9/20/76	raw		13.0	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

3	7/28/77	comb mill inf		<.3			4	9/20/76	r		10.0	1242
3	7/28/77	raw		<.2			4	9/20/76	f		13.0	
8	5/11/78	mill influent		nd			2+4	10/13/76	raw		59.0	1242
8	5/11/78	mill influent dup		nd			2+4	10/13/76	final		15.0	
8	5/11/78	final		nd			4	10/13/76	final		15.0	
7	4/7/83	final		<.5			4	10/13/76	final		22.0	
							4	10/13/76	raw		59.0	1242
							4	10/13/76	raw		62.0	1242
Fox River Water Column--||							4	10/13/76	r		62.0	1242
book	date	type	flow	conc	archlor		4	10/13/76	f		22.0	1242
1	7/11/73	Mason St Bridge		0.28	1248		2	10/28/76	final	ave of 10	10.0	
1	7/31/73	Mason St Bridge		0.38	1248		2+4	11/30/76	raw		50.0	1242
1	5/30/74	Mile .1 bouy 48		0.13	1242		2+4	11/30/76	final		29.0	1242
1	5/30/74	RC Dam		0.18	1242		4	11/30/76	raw		70.0	1242
1	5/30/74	Menasha		<.05			4	11/30/76	final		29.0	1242
1	6/4/74	Mouth		0.28	1242		4	11/30/76	r		70.0	1242
1	6/4/74	GB Turning lite		0.23	1242		4	11/30/76	f		29.0	1242
1+4	10/21/74	GBPack intake		0.13	1242		3	12/1/76	final		9.5	
1+4	12/17/74	RC Dam		0.08	1242		2	12/7/76	final	*	20.0	
1+4	12/17/74	@charmin		0.10	1242		2+4	12/16/76	raw	*	<4	
1	1/8/75	@Gilbert Paper		<.05			2	12/16/76	final	*	10.0	
1	3/4/75	@Ft how intake		0.30	1242		4	12/16/76	raw	*	<8	
4	6/1/75	at Gilbert Paper		0.05			4	12/16/76	final	*	<8	
2+4	1/14/76	@Charmin intak		0.57			IPC	1/2/77	Inf		16.0	1242
1	2/24/76	Health ctr rd off		<.1			IPC	1/2/77	Eff		23.0	1242
1	2/24/76	1 East Johnson		<.1			IPC	1/6/77	Inf		13.0	1242
1	2/24/76	Pt Sable		<.1			IPC	1/6/77	Eff		9.0	1242
1	2/24/76	GB Incinerator		<.1			2+4	1/7/77	raw		58.0	
1	2/24/76	Dead Horse Bay		<.1			2+4	1/7/77	raw		74.0	
1	2/24/76	Neenah Pt L Wi		<.1			2+4	1/7/77	final		16.0	1242
1	2/24/76	Bay Beach		<.1			4	1/7/77	final		18.0	1242
1	2/24/76	Pulliam Plant		<.1			4	1/7/77	f		18.0	
4	5/20/76	at Gilbert paper		<.05			IPC	1/9/77	Inf		12.0	1242
2	5/21/76	Menasha Chan		<.1			IPC	1/9/77	Eff		14.0	1242
2+4	5/20/76	@ Charmin inta		0.20	1242		IPC	1/13/77	Inf		396.0	1242
1	6/7/76	Below Cons		<.1			IPC	1/13/77	Eff		28.0	1242
2+4	7/20/76	llbdm rr bridge		<.1			IPC	1/16/77	Inf		305.0	1242
2+4	7/6/76	Ashwab Ck		<.05			IPC	1/16/77	Eff		15.0	1242
3	12/1/76	NC Winn.		<.1			IPC	1/18/77	3&4 sew		<6	1242
3	12/9/76	at mouth		0.25			IPC	1/18/77	5		<2	1242
3	12/13/76	at Appleton		<.1	1242		IPC	1/18/77	bldg 9-10		<8	1242
3	12/13/76	below Ft How		0.12	1242		IPC	1/18/77	decker		<16	1242
3	12/14/76	Rapid Croche		<.1			IPC	1/18/77	bleach waste		<2	1242
3	2/28/77	Doty Park NC		<.1			IPC	1/18/77	bldg 14		<4	1242
3	2/28/77	Fritz Park LLBD		0.85			IPC	1/18/77	Eff		20.0	1242
3	2/28/77	RR LLBDM		<.1			IPC	1/18/77	intake water		<1	1242
3	2/28/77	LLBDM 96th st		<.1			IPC	1/20/77	Inf	*	<9	1242
3	3/3/77	App Yacht Club		0.30	1242		IPC	1/20/77	Eff		16.0	1242
3	3/3/77	Kaukauna, Isl S		<.2			IPC	1/24/77	Inf		226.0	1242

Table C-1: Effluent PCB Data From the State Lab of Hygiene

3	3/3/77	Rapide Croche		<.2			IPC	1/24/77	Eff		20.0	1242
3	3/3/77	Depere Dam		<.2			IPC	1/27/77	Inf		215.0	1242
3	3/7/77	RR Mus. Gr Bay		<.2			IPC	1/27/77	Eff		27.0	1242
3	3/7/77	RR off Ft How		0.17			IPC	1/30/77	Inf	*	14.0	1242
3	3/7/77	300 yd off mouth		<.2			IPC	1/30/77	Eff		23.0	1242
3	3/7/77	at mouth		0.10			2+4	1/31/77	raw		6.7	1242
3	3/7/77	off rr mus GB		<.2			2+4	1/31/77	final		20.0	1242
3	3/7/77	distant shore fro		0.17			4	1/31/77	raw		9.3	1242
3	3/7/77	Fox mouth		0.10			4	1/31/77	final		23.0	1242
3	3/8/77	Pulliam		<.3			4	1/31/77	r		9.3	1242
3	7/20/77	doty park		<.05			4	1/31/77	f		23.0	1242
3	7/22/77	abv appleton da		-			IPC	1/31/77	Inf/DNR split		9.3	1242
3	7/27/77	at wrigthstown		0.24			IPC	1/31/77	Eff/DNR split		23.0	1242
3	7/27/77	at depere		0.14			IPC	2/3/77	Inf	*	<14	1242
3	7/27/77	at ft how		0.30			IPC	2/3/77	Eff		20.0	1242
							IPC	2/6/77	Inf	*	6.5	1242
							IPC	2/6/77	Eff		13.0	1242
Paper Samples--							IPC	2/8/77	3&4 sew		3.8	1242
book	date	type	flow	PPB	archlor		IPC	2/8/77	5	*	2.2	1242
1	5/74	pest rept form		4800	1242		IPC	2/8/77	bldg 9-10		<34	1242
1	5/74	1974 NCR Pape		1100	1242		IPC	2/8/77	decker	*	33.0	1242
1	1/22/75	DNR timesheet		7500	1242		IPC	2/8/77	bleach waste		<64	1242
1	1/22/75	computer ccp		1500	1242		IPC	2/8/77	bldg 14		<50	1242
1	"	"		1500	1242		IPC	2/8/77	intake water		<2	1242
1	1/30/75	newspaper		<200			IPC	2/8/77	sludge		2.8ppm	1242
1	2/17/75	1975 NCR Pape		<100			2+4	2/10/77	raw		40.0	1242
1	2/17/75	paper towel		<200			2+4	2/10/77	final	*	<5	
							IPC	2/10/77	Inf/DNR split		23.0	1242
							IPC	2/10/77	Eff/DNR split		26.0	1242
							3	2/12/77	raw		<5	
							3	2/12/77	final		40.0	
							IPC	2/13/77	Inf		231.0	1242
							IPC	2/13/77	Eff		26.0	1242
							4	2/16/77	final		<5	
							IPC	2/17/77	Inf		29.0	1242
							IPC	2/17/77	Eff		18.0	1242
							IPC	2/20/77	Inf		89.0	1242
							IPC	2/20/77	Eff		44.0	1242
							IPC	2/24/77	Inf		34.0	1242
							IPC	2/24/77	Eff		29.0	1242
							IPC	2/27/77	Inf/DNR split		68.0	1242
							IPC	2/27/77	Eff/DNR split		70.0	1242
							3	2/28/77	final		68.0	1242
							3	2/28/77	raw		79.0	1242
							IPC	3/1/77	Inf/DNR split		70.0	1242
							IPC	3/2/77	Inf/DNR split		24.0	1242
							IPC	3/2/77	Eff/DNR split		73.0	1242
							3	3/3/77	primary	*	29.0	
							3	3/3/77	raw		80.0	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

							3	3/3/77	final		56.0	
							IPC	3/3/77	Inf		160.0	1242
							IPC	3/3/77	Eff		118.0	1242
							IPC	3/6/77	Inf		267.0	1242
							IPC	3/6/77	Eff		49.0	1242

Table C-1: Effluent PCB Data From the State Lab of Hygiene

Dates of samples are sometimes lab analysis dates and not sampling dates.												
This could not be determined from lab books.												
P H GLATFELTER COMPANY---(cont.)---------||							WISCONSIN TISSUE MILLS--------------------||					
book	date	type	flow	conc	archlor		book	date	type	flow	conc	archlor
IPC	3/8/77	3&4 se*		2.1	1242		WT	12/18/73	final eff		<.1	
IPC	3/8/77	5	*	6.0	1242		WT	11/21/74	final eff		<.1	
IPC	3/8/77	bldg 9-10		12.0	1242		WT	2/27/75	final eff		6.00	1242
IPC	3/8/77	decker		18.0	1242		WT	5/22/75	final eff		<.5	
IPC	3/8/77	bleach	*	4.7	1242		WT	9/16/75	final eff		<.5	
IPC	3/8/77	bldg 14*		18.0	1242		WT	1/7/76	final eff		2.10	
IPC	3/8/77	intake water		nd	1242		WT	1/8/76	final eff		1.10	
IPC	3/8/77	sludge		11.9ppm	1242		WT	1/9/76	final eff		1.10	
IPC	3/8/77	Inf		87.0	1242		WT	1/10/76	final eff		1.30	
IPC	3/8/77	Eff		47.0	1242		WT	1/11/76	final eff		0.80	
2+4	3/10/77	final		27.0	1242		WT	1/12/76	final eff		1.60	
2+4	3/10/77	raw	*	<20			WT	1/13/76	final eff		1.80	
IPC	3/10/77	Inf	*	10.0	1242		2+4	1/13/76	sludge		42ppm d	1242
IPC	3/10/77	Eff		56.0	1242		2	1/13/76	raw to nm stp		130.00	
IPC	3/13/77	Inf		20.0	1242		2	1/13/76	raw to nm stp		91.40	
IPC	3/13/77	Eff		21.0	1242		2	1/13/76	final to nm stp		0.58	
IPC	3/17/77	Inf		29.0	1242		2+4	1/13/76	raw to nm stp		180.00	1242
IPC	3/17/77	Eff		26.0	1242		2+4	1/13/76	final to nm stp		1.40	1242
IPC	3/20/77	Inf		18.9	1242		WT	1/14/76	final eff		0.50	
IPC	3/20/77	Eff		18.9	1242		WT	1/15/76	final eff		1.40	
IPC	3/24/77	Inf		233.0	1242		WT	1/16/76	final eff		4.00	
IPC	3/24/77	Eff		30.0	1242		WT	1/17/76	final eff		1.90	
IPC	3/27/77	Inf		11.0	1242		4	1/28/76	raw		340.00	
IPC	3/27/77	Eff		25.0	1242		2	1/29/76	raw to nm stp		346.00	
IPC	3/31/77	Inf		18.0	1242		2+4	1/29/76	final to nm stp		3.20	
IPC	3/31/77	Eff		17.0	1242		2+4	1/30/76	final to nm stp		3.20	
IPC	4/3/77	Inf		72.0	1242		2+4	7/20/76	final to riv		1.10	1242
IPC	4/3/77	Eff		24.0	1242		2	7/20/76	final/epa to riv		1.10	1242
2+4	4/6/77	raw		19.0			3	12/1/76	final		0.30	
2+4	4/6/77	final		12.0	1242		3	2/28/77	final		1.40	1242
4	4/6/77	final		18.0	1242		3	2/28/77	raw		25.00	1242
4	4/6/77	f		18.0	1242		3	2/28/77	primary		2.20	1242
2+4	4/19/77	raw		59.0	1242		WT	7/10/77	final eff		<.5	
2+4	4/19/77	final		55.0	1242		3	7/20/77	wet well solids?		8200	
4	4/19/77	r		28.0	1242		3	7/20/77	final		<.2	
4	4/19/77	f		61.0	1242		WT	8/26/77	final eff		<.5	
2+4	5/6/77	raw		~20			WT	3/23/78	final eff		<.5	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

2+4	5/6/77	final		18.0	1242
4	5/6/77	f		18.0	1242
2+4	5/20/77	final	*	20.0	
4	5/20/77	r		12.0	
4	5/20/77	f		12.0	
2+4	6/2/77	raw		10.0	
2+4	6/2/77	final	s=102	30.0	1242
4	6/2/77	f		11.0	1242
IPC	6/6/77	3&4 sew		0.7	1242
IPC	6/6/77	5	*	2.0	1242
IPC	6/6/77	bldg 9	*	<11	1242
IPC	6/6/77	decker		59.0	1242
IPC	6/6/77	bleach	*	<17	1242
IPC	6/6/77	bldg 14	*	<33	1242
IPC	6/6/77	intake water		0.6	1242
IPC	6/6/77	sludge		1.9ppm	1242
IPC	6/6/77	Inf		28.0	1242
IPC	6/6/77	Eff		15.0	1242
2+4	6/17/77	final		59.0	1242
2+4	6/17/77	raw	*	20.0	
4	6/17/77	r		~21	
4	6/17/77	f		69.0	1242
2+4	6/30/77	final		12.0	1242
2+4	6/30/77	raw	*	<30	
2+4	7/15/77	final		44.0	1242
2+4	7/15/77	raw	* s=1130	11.0	
4	7/15/77	f		46.0	1242
3	7/20/77	final		25.0	
3	7/20/77	raw		<10	
2	7/28/77	raw		100.0	
2+4	7/28/77	raw		90.0	1242
2+4	7/28/77	final		10.0	1242
4	7/28/77	r		31.0	1242
4	7/28/77	f		7.0	1242
3	8/10/77	final		16.0	
2+4	8/11/77	final		10.0	
2+4	8/11/77	raw		75.0	
4	8/11/77	r		59.0	1242
4	8/11/77	f		6.5	1242
2+4	8/25/77	raw		120.0	
2+4	8/25/77	final	*	1.1	
2+4	9/8/77	final		8.0	1242
2+4	9/8/77	raw		<20	
4	9/8/77	f		23.0	1242
2+4	9/22/77	final		1.2	1242
2+4	9/22/77	raw		13.0	1242
4	9/22/77	r		7.0	1242
2+4	10/20/77	final		17.0	1242
2+4	10/20/77	raw		67.0	1242

8	5/18/78	raw		25.00	
8	5/18/78	final		nd	
8	6/30/78	raw		<.6	
8	6/30/78	final		<.7	
WT	11/12/78	final eff		<.5	
WT	12/6/78	final eff		<.5	
WT	6/7/79	final eff		<.5	
WT	9/25/79	final eff		<.5	
WT	11/12/79	final eff		<.5	
WT	3/6/80	final eff		<.5	
WT	6/5/80	final eff		<.5	
WT	9/16/80	final eff		<.5	
WT	12/1/80	final eff		<.5	
WT	12/4/80	final eff		<1.	
WT	12/18/80	final eff		<1.	
WT	3/17/81	final eff		<2.	
WT	6/2/81	final eff		<.8	
WT	9/2/81	final eff		<2.	
WT	12/3/81	final eff		<.5	
WT	3/7/82	final eff		<.5	
WT	6/7/82	final eff		<.5	
WT	7/29/82	final eff		<.5	
WT	8/11/82	final eff		<.5	
WT	9/10/82	final eff		<..3	
WT	9/21/82	final eff		<..3	
7	6/7/83	final		<.5	
KC - NEENAH/BADGER GLOBE-----------------||					
book	date	type	flow	conc	archlor
1	3/1/73	final		<.05	
3	12/1/76	final		<.1	
3	2/28/77	final	clarifier	0.30	
3	2/28/77	raw		<.2	
3	2/28/77	primar	clarifier	<.2	
3	7/20/77	final		<.2	
8	8/10/78	raw		nd	
8	8/10/78	final		nd	
7	5/17/83	final		0.60	1242
US PAPER-MENASHA DIVISION--------------||					
book	date	type	flow	conc	archlor
1	3/14/73	final		<.05	
1	11/4/74	raw/fe	1.80	4.00	1242
4	7/17/75	final		0.87	1242
4	10/17/75	final	0.48	4.00	1242
N101	1/4/76	final		0.05	
2	1/27/76	raw/felt		2.60	
2	1/27/76	raw/felt		2.40	
2	4/1/76			0.50	1248

Table C-1: Effluent PCB Data From the State Lab of Hygiene

4	10/20/77	r		46.0	1242	USP	1/9/79	eff		<.05	
4	10/20/77	f		24.0	1242	USP	10/3/84	eff		<.5	
2+4	11/2/77	final		2.4	1242						
2+4	11/2/77	raw		195.0	1242	Neenah Foundary---------------------------------------||					
2	11/2/77	raw		170.0		book	date	type	flow	conc	archlor
4	11/2/77	r		115.0	1242	1+4	8/1/75	plant 1	0.830	0.10	
4	11/2/77	f		1.8	1242	1+4	'8/1/75	plant 2	1.317	2.40	1254
4	11/14/77	r	*	<20	1242						
4	11/14/77	r	*	<12	1242	AMERICAN TISSUE MILLS---------------------||					
4	11/14/77	f		4.0	1242	book	date	type	flow	conc	archlor
4	11/14/77	f		2.0	1242	1	11/4/74	final/cl	5.16	0.28	1242
2+4	12/1/77	final		30.0	1242	4	10/16/75	final	3.43	0.26	1242
2+4	12/1/77	raw		125.0	1242	2+4	7/20/76	final		<.2	
4	12/1/77	r		106.0	1242	3	12/1/76	final		0.20	1242
4	12/1/77	f		28.0	1242	3	2/28/77	final		0.15	
2+4	12/14/77	final		2.0	1242	3	3/23/77	final		1.20	
2+4	12/14/77	raw		100.0	1242	3	3/23/77	raw		19.00	1242
2+4	12/27/77	final		3.0	1242	3	7/20/77	final		<.3	
2+4	12/27/77	raw		20.0	1242	8	9/7/78	raw		0.40	
2+4	1/11/78	final		6.0	1242	8	9/7/78	final		nd	
2+4	1/11/78	raw		570.0	1242	7	5/17/83	final		<.5	
2+4	1/11/78	raw		793.0	1242						
2+4	1/25/78	final		8.2	1242	GEORGE WHITING PAPER CORPORATION					
2+4	1/25/78	raw		29.0	1242	book	date	type	flow	conc	archlor
2+4	2/8/78	final		12.0	1242	3	12/1/76	final		<.2	
2+4	2/8/78	raw		13.0	1242	3	7/20/77	final		<.3	
2+4	2/22/78	final		9.5	1242	3	7/20/77	raw		<.2	
2+4	2/22/78	raw		344.0	1242	8	9/7/78	raw		nd	
2+4	2/22/78	raw		322.0	1242	8	9/7/78	final		nd	
2+4	3/8/78	final		2.4	1242						
2+4	3/8/78	raw		48.0	1242	MEAD - GILBERT PAPER DIVISION----------||					
2+4	3/23/78	final	*	1.0	1242	book	date	type	flow	conc	archlor
2+4	3/23/78	raw	*	10.0	1242	no data found					
8	3/30/78	final		0.4							
8	3/30/78	raw		3.2		RIVERSIDE PAPER-KERWIN DIVISION------||					
2+4	4/5/78	raw		75.0	1242	book	date	type	flow	conc	archlor
2+4	4/5/78	final		2.1	1242	1	5/30/74	to sewer		2.60	1242
2+4	4/19/78	raw	*	32.0	1242	Riv	12/5/74	001/002		<1	
2	4/19/78	final		la		Riv	12/5/74	003		3.00	1242
2+4	5/3/78	raw		97.0	1242	Riv	7/16/75	001/002		<.1	
2+4	5/3/78	final		3.0	1242	2+5	2/12/76	final	0.044	3.60	1248
2+4	5/16/78	final		2.2	1242	Riv	12/7/76	001/002		<.5	
2+4	5/16/78	raw		la		Riv	12/7/76	003		<.5	
2	5/27/78	final		2.0	1242	3	12/9/76	final		<.1	
2+4	6/1/78	raw		160.0		3	12/9/76	final		<.1	
2+4	6/1/78	final		<2	1242	Riv	12/5/77	001/002		<.5	
2+4	6/14/78	raw		120.0	1242	Riv	12/5/77	001/002		<.5	
2+4	6/14/78	final		1.4	1242	8	9/22/78	final		nd	
2+4	6/28/78	raw	*	<10	1242	Riv	12/21/78	river		<.5	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

2+4	6/28/78	final	*	<1	1242		Riv	12/21/78	clearwell		<.5	
8	6/29/78	final		<2			Riv	12/21/78	001/002		<.5	
8	6/29/78	raw		<9			Riv	12/21/78	003/004		<.5	
2	7/12/78	raw	*	20.0			Riv	3/14/79	001/002		<.5	
2+4	7/12/78	final		<.4			Riv	6/6/79	001/002		<.5	
7	2/9/83	final		<2			Riv	12/4/79	river		<.5	
							Riv	12/4/79	clearwell		<.5	
							Riv	12/4/79	001/002		<.5	
							Riv	12/4/79	003/004		2.20	
							Riv	12/12/79	001/002		<.5	
							Riv	12/18/79	river		<300	
							Riv	12/18/79	clearwell		<300	
							Riv	12/18/79	001		<300	
							Riv	12/18/79	002		<300	
							Riv	3/6/80	001/002		<.5	
							Riv	9/12/80	001/002		<.5	
							Riv	12/4/80	river		<.5	
							Riv	12/4/80	clearwell		<.5	
							Riv	12/4/80	001/002		500.00	typo?
							Riv	12/4/80	003/004		<.5	
							Riv	3/20/81	001/002		<.5	
							Riv	4/17/81	001/002		<.5	
							Riv	6/5/81	001		<.5	
							Riv	9/4/81	001		<.5	
							Riv	11/19/81	001		<.5	
							Riv	12/2/81	river		<.5	
							Riv	12/2/81	clearwell		<.5	
							Riv	12/2/81	001		<.5	
							Riv	12/2/81	003/004		<.5	
							Riv	1/13/82	001		<.5	
							Riv	4/9/82	001		<.5	
							7	2/10/83	final		<.5	
							Riv	2/10/83	001		<.5	
							Riv	3/29/84	001		<.5	
							Riv	11/7/84	clearwell		<.5	
							Riv	11/14/84	clearwell		<.5	
							Riv	11/14/84	001		<.5	
							Riv	11/21/84	clearwell		<.5	
							Riv	11/24/84	001		<.5	
							Riv	1/29/85	001		<.5	
							Riv	10/12/88	001		0.50	1221/123
							001/002=POTW, 003/004=river					
							CONSOLIDATED PAPER, APPLETON------||					
							book	date	type	flow	conc	archlor
							3	12/9/76	final		7.00	1254
							3	12/9/76	raw		<.2	
							3	7/22/77	final		<.2	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

CONSOLIDATED PAPER, INTERLAKE MILL					
book	date	type	flow	conc	archlor
Beh	8/28/73	f		<.05	
3	12/13/76	final		<.1	
3	3/3/77	raw		<.2	
3	3/3/77	final		<.2	
3	7/22/77	raw		<.2	
3	7/22/77	final		<.3	
8	9/22/78	final		nd	
8	9/22/78	raw		<.5	
Appleton Coated Paper-------------------------------||					
book	date	type	flow	conc	archlor
1	5/30/74	to sewer		5.00	1242
Appleton Electric---||					
book	date	type	flow	conc	archlor
2	2/17/79	?		2.00	
APPLETON PAPERS - LOCKS MILL----------||					
book	date	type	flow	conc	archlor
1	5/30/74	final		5.00	1242
3	12/13/76	final		<.2	
3	3/3/77	raw		<.2	
3	3/3/77	primary		<.2	
3	3/3/77	final		<.2	
3	7/22/77	raw		<.2	
3	7/22/77	final		<.2	
8	9/28/78	raw		nd	
8	9/28/78	final		nd	
7	4/4/83	final		<.5	
INTERNATIONAL PAPER-THILMANY DIVISION					
book	date	type	flow	conc	archlor
1	11/4/74	final/la	21.75	<.1	
5	10/30/75	lagoon 2		0.10	
2+5	3/3/76	unbl kraft pulp		<.1	
2+5	3/3/76	purchased pine		<.05	
3	12/9/76	final		<.2	
3	3/3/77	raw		<.2	
3	3/3/77	final		<.2	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

							3	7/22/77	final		<.1	
							3	7/22/77	lagoon		<.2	
							3	7/22/77	main mill		<.1	
							8	7/27/78	pulp		nd	
							8	7/27/78	final		nd	
							8	7/27/78	final dup		<.2	
							7	4/4/83	final		<.5	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

1 Old Fish Book done 6/25/97 djp 32 hours					
2 SDWA Book done 7/3/97 djp 25 hours					
3 EPA Book done 9/9/97 djp 30 hours					
4 Winn Cty done 9/18/97 djp 4 hours					
5 Outagamie Cty done 9/18/97 djp 2 hours					
6 Brown Cty done 9/18/97 djp 4 hours					
7 Pesticide and Toxic Metals done 9/19/97 (Jopke spreadsheet) djp 2 hours					
8 Toxic Organic Substances Project done 9/11/97 djp 8 hours					
FORT JAMES CORPORATION, GREEN BAY WEST MILL					
book	date	type	flow	conc	archlor
6	7/8/74	final combined		4.40	
1+6	9/11/74	final/de	10.69	6.40	1242
1+6	9/11/74	final/pa	7.82	2.60	1242
1+6	3/4/75	final co	18.00	6.80	1242
1+6	5/6/75	final combined o		10.00	1242
FTH	5/8/75	final		NA	
FTH	6/11/75	final	16.48	7.10	
FTH	6/23/75	final	18.88	3.90	
FTH	7/2/75	final	18.89	1.40	
FTH	7/8/75	final	20.61	1.85	
fhrep	7/9/75	final com		4.40	
FTH	7/9/75	final/sp	17.94	2.00	
FTH	7/17/75	final	15.66	2.60	
FTH	8/6/75	final	18.42	0.63	
FTH	8/18/75	final	18.61	5.18	
1+6	8/21/75	final combined		14.00	1242
FTH	8/21/75	final	16.65	1.21	
FTH	8/22/75	final/sp	18.09	1.21	
2+6	10/2/75	final combined		160.00	1242
FTH	10/2/75	final	19.39	3.30	
FTH	10/22/75	final	20.39	no	
2+6	12/19/75	final combined		56.00	1242
FTH	12/19/75	final	10.24	18.05	
FTH	12/19/75	final	10.24	24.00	
FTH	12/19/75	final/sp	10.24	18.00	
2+6	1/8/76	final combined		31.00	1242
2+6	1/8/76	final combined		32.00	1242
FTH	1/8/76	final	17.59	16.10	
2+6	1/15/76	final combined		31.00	1242
2	1/15/76	final		29.80	
FTH	1/15/76	final	17.21	5.60	
FTH	1/15/76	final	17.21	14.60	
2+6	1/21/76	final combined		3.50	1242
FTH	1/21/76	final/sp	17.01	31.00	
FTH	1/21/76	final/sp	17.01	30.00	
FTH	1/21/76	final/sp	17.01	33.00	
FTH	1/21/76	final/sp	17.01	31.00	

Table C-1: Effluent PCB Data From the State Lab of Hygiene

2+6	1/22/76	raw		115.00	1242			
2	1/22/76	raw		123.00				
FTH	1/22/76	final	17.68	2.80				
FTH	1/22/76	final/dn	17.68	115.00				
2+6	1/29/76	final combined		6.00	1242			
2+6	1/29/76	sludge		225ppmwet				
FTH	1/29/76	final	16.54	1.42				
2+6	2/4/76	final 002		1.40	1242			
FTH	2/5/76	final	17.12	1.32				
2+6	2/12/76	final 001		3.20	1242			
FTH	2/12/76	final	17.69	1.62				
FTH	3/11/76	final	17.07	0.93				
2+6	4/21/76	final 002		1.20	1242			
FTH	4/22/76	final	18.1	1.04				
2	5/13/76	final epa		1.20				
FTH	5/13/76	final/sp	20.33	1.2/1.2				
2	5/26/76	final		11.30	1242			
FTH	5/27/76	final	19.01	2.26				
FTH	6/1/76	final	19.72	1.41				
FTH	6/2/76	final	18.84	1.14				
FTH	6/3/76	final	19.24	1.08				
FTH	6/4/76	final	16.78	0.97				
FTH	6/5/76	final	17.67	0.82				
FTH	6/6/76	final	18.09	0.67				
FTH	6/7/76	final	17.73	0.54				
FTH	6/8/76	final	17.9	0.48				
FTH	6/9/76	final	19.11	0.70				
FTH	6/10/76	final	19.62	0.50				
FTH	6/11/76	final	19.17	0.58				
FTH	6/12/76	final	19.49	0.75				
FTH	6/13/76	final	20.05	0.85				
FTH	6/14/76	final	19.58	0.70				
FTH	6/15/76	final	18.79	0.82				
FTH	6/16/76	final	19.17	0.77				
FTH	6/17/76	final	18.53	1.08				
FTH	6/18/76	final	20.1	0.76				
FTH	6/19/76	final	19.6	1.01				
FTH	6/20/76	final	19.45	1.07				
FTH	6/21/76	final	19.91	1.06				
FTH	6/22/76	final	18.59	1.32				
FTH	6/23/76	final	19.6	1.45				
2+6	6/24/76	final		8.50	1242			
FTH	6/24/76	final	15	1.64				
FTH	6/24/76	final	15	0.66				
FTH	6/25/76	final	15.93	0.70				
FTH	6/26/76	final	20.66	0.90				
FTH	6/27/76	final	20.1	1.00				
FTH	6/28/76	final	20.18	0.83				
FTH	6/29/76	final	20.97	1.01				

Table C-1: Effluent PCB Data From the State Lab of Hygiene

FTH	6/30/76	final	19.05	1.06				
6	7/29/76	final 002		3.40	1242			
FTH	7/29/76	final	20.83	1.20				
2	8/30/76	final		8.40	1242			
FTH	8/31/76	final	21.73	3.06				
2+6	9/22/76	final		1.10	1242			
2+6	9/22/76	final	dup	1.60	1242			
FTH	9/23/76	final	18.36	0.71				
2+6	10/28/76	final ave of 10		4.80				
FTH	10/28/76	final	19.5	1.85				
2+6	11/24/76	final	*	<5	1242			
FTH	11/24/76	final	17.31	0.79				
FTH	11/24/76	final	17.31	0.76				
FTH	12/6/76	final	18.68	2.58				
3	12/9/76	final		3.70	1242			
2+6	12/21/76	final 002		0.80	1242			
FTH	12/22/76	final	16.11	0.82				
2+6	1/24/77	final 002		2.50	1242			
FTH	1/25/77	final	20.13	2.78				
2+6	2/25/77	final		1.40				
FTH	2/25/77	final	16.96	0.64				
FTH	3/5/77	final	17.84	0.84				
3	3/7/77	final		1.20				
FTH	3/15/77	final	18.63	1.96				
FTH	3/15/77	final	18.63	3.48				
FTH	3/15/77	final	18.63	3.23				
FTH	3/19/77	final	19.38	1.25				
2+6	3/30/77	final		1.30	1242			
FTH	3/31/77	final	19.27	1.27				
FTH	4/4/77	final	18.7	1.82				
FTH	4/7/77	final	20.01	1.48				
3+6	4/15/77	final 002		2.00	1242			
3+6	4/15/77	final 002 dup		1.20	1242			
FTH	4/15/77	final	19.7	2.02				
2+6	5/27/77	final		10.00				
6	5/27/77	final 002		10.00				
FTH	5/27/77	final	19.25	2.10				
FTH	7/25/77	final	18.71	7.33				
3	7/27/77	final		7.70				
2	7/28/77	final		10.00				
FTH	7/29/77	final	20.14	5.06				
FTH	8/9/77	final	17.91	2.68				
3	8/10/77	final		5.40				
2+6	8/29/77	final		33.00				
FTH	8/30/77	final	19.37	12.67				
2+6	9/29/77	final		11.00				
FTH	9/30/77	final	17.42	5.29				
FTH	10/11/77	final	17.48	7.97				
2	12/27/77	final		1.50	1242			

Table C-1: Effluent PCB Data From the State Lab of Hygiene

6	12/28/77	final 002		1.50	1242			
FTH	12/29/77	final	15.55	2.56				
2	1/26/78	final		1.70				
6	1/26/78	final 002		1.70	1242			
FTH	1/26/78	final	17.77	1.50				
2	2/22/78	final		4.00				
2	2/22/78	final		4.50				
6	2/22/78	final 002		4.20	1242			
FTH	2/24/78	final	16.01	2.48				
2	3/27/78	final		8.10				
FTH	3/28/78	final	13.09	5.17				
8	3/29/78	final		8.10				
6	5/1/78	final 002		2.20	1242			
FTH	5/2/78	final	18.26	0.80				
2	5/3/78	final		2.20	1248			
6	5/24/78	final 002		2.00	1242			
FTH	5/25/78	final	19.74	0.89				
FTH	6/27/78	final	16.6	0.67				
FTH	7/14/78	final	18.97	0.77				
2	7/26/78	final		23.00				
FTH	1/25/79	final	17.69	0.67				
FTH	2/6/79	final	16.76	1.16				
7	6/7/83	final		<.5				
FORT JAMES CORPORATION, GREEN BAY EAST MILL								
book	date	type	flow	conc	archlor			
1	1/30/74	final		<.04				
N101	9/6/74	final		8.00				
1+6	11/4/74 or	sulfite	7.20	0.10	1242			
1+6	11/4/74 or	final/la	22.00	0.14	1242			
2+6	1/25/76	final		<.2				
Beh	1/25/76	final	4.75	0.20				
2	1/26/76	sludge		1.3ppmdry				
3	12/9/76	final		<.2				
3	1/27/77	final		<.1				
3	1/27/77	raw		<.2				
3	3/8/77	final/lagoon		<.2				
3	3/8/77	raw to lagoon		<.2				
3	7/27/77	final		<.2				
8	4/12/78	final		nd				
8	4/12/78	raw		nd				
8	9/8/78	final lagoons		nd				
8	9/8/78	raw to lagoons		nd				
PROCTER AND GAMBLE PAPER PRODUCTS COMPANY								
book	date	type	flow	conc	archlor			

Table C-1: Effluent PCB Data From the State Lab of Hygiene

1+6	9/25/74	final		0.14	1242
Beh	1/14/76	final	11.00	0.20	
2+6	1/14/76	final		<.2	
4	1/14/76	fines to landfill		<.5 dry	
2	1/21/76	landfill fines		<.5ppm dry	
3	12/9/76	final		<.2	
3	3/8/77	final		<.2	
3	3/8/77	raw		<.2	
3	7/27/77	final		<.3	
8	4/25/78	final		nd	
GREEN BAY PACKAGING INCORPORATED					
book	date	type	flow	conc	archlor
Beh	10/21/74	final	1.00	0.45	
1	11/4/74	final	2.08	0.45	1242
3	12/9/76	final		<.2	
3	7/27/77	final		0.37	
8	4/12/78	final		nd	
INTERNATIONAL PAPER-NICOLET PAPER DIVISION					
book	date	type	flow	conc	archlor
3	12/14/76	final		<.2	
3	3/8/77	final		<.2	
3	3/8/77	raw		<.3	
3	3/9/77	final		<.2	
3	3/9/77	raw		0.20	1242+1254
3	7/27/77	final		<.2	
8	3/29/78	raw		0.06	
7	6/7/83	final		<.5	
7	6/7/83	?		<.5	

Appendix D

Estimated PCB Releases by Discharger: 1954 to 1997

This appendix presents a spreadsheet showing PCB discharges by year. The discharge estimated presented are base on a production loss rate of 3% and a partitioning factor of 25%. The loss rate only impacts estimates from facilities where NCR Paper was produced. The partitioning factor only impacts estimates from deinking facilities. It should be noted that in addition to a discharge through the Neenah-Menasha POTW, Wisconsin Tissue also had a direct discharge to the river after 1973. This direct discharge from Wisconsin Tissue was very small (12 kg) and was included in the sum of all other discharges.

Table D-1: PCB Load by Discharger Assuming 25% of PCB to Product and 3% Loss

Estimated PCB Loads to the					
Lower Fox River: 1954 to 1997					
Non NCR					
Paper		M1.5/WP&B	/WP&B	M2/WP&B	M2/WP&P
Fiber	YEAR	PH Glatfelter	PH Glatfelter L	NM POTW	App POTW
Furnish			Landfill	Wis Tiss	App. Coated
Factor		PCB #/YR	PCB #/YR	PCB #/YR	PCB #/YR
0.0239	1954	288.1	48.2	110.2	424.1
0.0655	1955	1268.1	190.2	541.7	2783.0
0.1091	1956	2293.4	326.4	709.4	4196.6
0.1152	1957	2464.2	390.2	937.5	4638.3
0.1294	1958	4031.6	545.0	1171.1	6272.8
0.1734	1959	4868.9	730.3	1980.6	8923.2
0.1845	1960	4870.1	730.5	1966.1	9340.6
0.2442	1961	7246.2	1086.9	2096.4	13550.9
0.2893	1962	8686.8	1303.0	2489.5	18146.6
0.3383	1963	10767.1	1615.1	2418.9	21363.7
0.4015	1964	11996.1	1799.4	2433.7	9676.5
0.5127	1965	12635.3	1895.3	5641.1	12763.9
0.6193	1966	16264.5	2439.7	7676.2	15853.4
0.6624	1967	14502.4	2175.4	5819.9	17285.2
0.8706	1968	19047.7	2857.1	8634.9	25496.9
0.9594	1969	22650.9	3397.6	11297.2	54369.8
1.0000	1970	14946.7	2242.0	10691.9	33404.2
1.0000	1971	2875.0	431.2	1749.6	5903.4
1.0000	1972	241.2	36.2	15.0	0.0
1.0000	1973	234.4	35.2	0.1	0.0
1.0000	1974	222.7	33.4	2.3	0.0
1.0000	1975	262.8	39.4	1.6	0.0
1.0000	1976	190.5	0.0	0.8	0.0
1.0000	1977	197.7	0.0	0.3	0.0
0.8607	1978	23.0	0.0	0.3	0.0
0.7408	1979	35.2	0.0	0.2	0.2
0.6376	1980	28.6	0.0	0.1	0.0
0.5488	1981	25.0	0.0	0.1	0.0
0.4724	1982	15.4	0.0	0.3	0.0
0.4066	1983	11.0	0.0	0.1	0.0
0.3499	1984	3.0	0.0	0.1	0.0
0.3012	1985	2.9	0.0	0.1	0.0
0.2592	1986	2.7	0.0	0.1	0.0
0.2231	1987	4.0	0.0	0.1	0.0
0.1920	1988	2.9	0.0	0.0	0.0
0.1653	1989	1.9	0.0	0.0	0.0
0.1423	1990	3.6	0.0	0.0	0.0
0.1225	1991	2.8	0.0	0.0	0.0
0.1054	1992	2.8	0.0	0.0	0.0
0.0907	1993	1.9	0.0	0.0	0.0
0.0781	1994	1.7	0.0	0.0	0.0
0.0672	1995	2.2	0.0	0.0	0.0
0.0578	1996	1.7	0.0	0.0	0.0
0.0498	1997	1.1	0.0	0.0	0.0
		===============	===============	===============	===============
Total LBS		163226	24348	68388	264393
Total KGs		74025	11042	31015	119906
Percent		23.60%	3.52%	9.89%	38.23%

Table D-1: PCB Load by Discharger Assuming 25% of PCB to Product and 3% Loss

Broke split proportional to deink production.				
Production loss = 3%.				
PCB to fiber = 25%.				
M1.5/WP&B&P	M1.5/WP&B			
AppPap-Locks Mill	Ft James West	Sum of Other	Total	Total
		Discharges	Load	Load
PCB #/YR	PCB #/YR	PCB #/YR	PCB #/YR	PCB KG/YR
13.8	279.4	10.4	1174	533
51.9	1096.2	24.7	5956	2701
77.0	1651.7	31.7	9286	4211
85.8	1663.4	45.4	10225	4637
109.1	2069.0	52.7	14251	6463
170.6	2956.4	69.0	19699	8934
170.4	3367.7	63.4	20509	9301
217.9	4714.2	88.9	29001	13153
239.5	6377.3	115.4	37358	16942
236.4	7183.8	94.2	43679	19809
282.9	8617.0	89.1	34895	15825
290.8	11044.2	114.2	44385	20129
227.5	13101.4	136.1	55699	25260
198.2	13297.4	140.2	53419	24226
288.0	17646.8	182.8	74154	33630
2941.5	22619.5	201.9	117479	53278
3153.5	25047.6	186.1	89672	40668
1134.4	6006.4	2525.2	20625	9354
654.4	1756.4	103.7	2807	1273
97.3	865.9	75.1	1308	593
110.9	229.1	42.3	641	291
59.3	1313.3	27.5	1704	773
1.6	262.4	41.0	496	225
2.0	210.5	26.9	437	198
1.9	202.6	25.9	254	115
2.0	482.5	24.7	545	247
2.0	495.5	20.2	546	248
2.0	290.4	19.0	337	153
2.0	213.1	15.4	246	112
3.6	24.3	25.0	64	29
2.0	113.7	12.4	131	60
7.6	106.1	10.4	127	58
2.7	67.6	9.3	82	37
1.9	46.9	6.7	60	27
3.3	43.9	5.2	55	25
2.3	43.0	4.5	52	23
3.2	21.2	5.0	33	15
2.7	22.4	3.9	32	14
1.3	16.7	3.1	24	11
1.7	18.2	2.4	24	11
1.3	16.8	2.1	22	10
2.1	19.3	1.6	25	11
1.8	10.0	1.6	15	7
1.1	4.9	1.3	8	4
==============	==============	==============	===============	===============
10863	155636	4688	691542	313624
4926	70583	2126	313624	313624
1.57%	22.51%	0.68%	100.00%	100.00%